electronics engineering edition

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electronics

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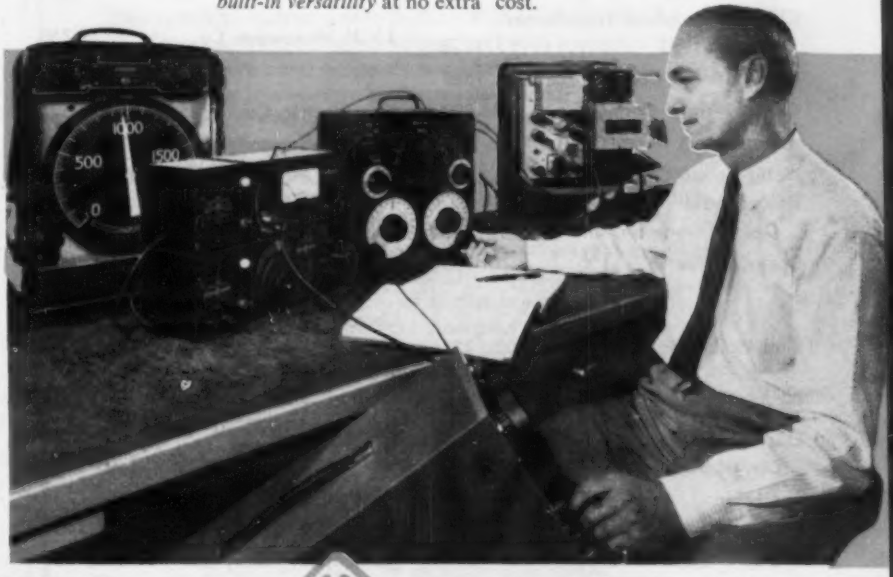

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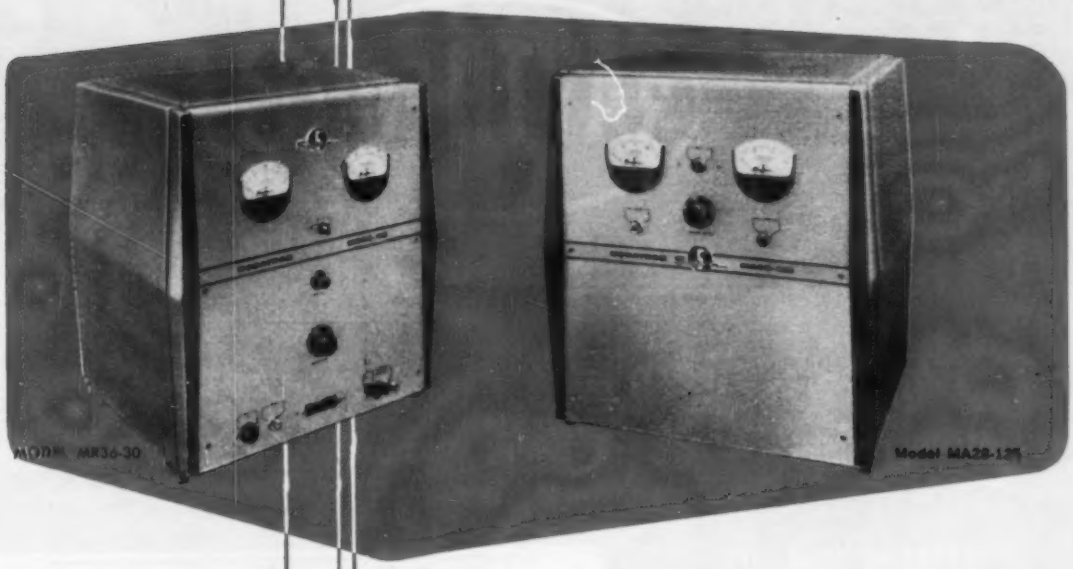

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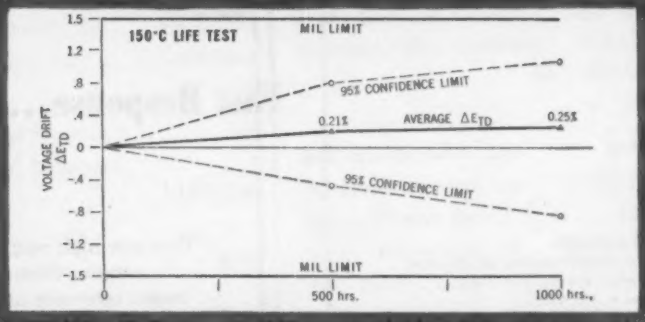

	MIL Limit Maximum	Typical CK 5651WA	Units
DARK STARTING VOLTAGE	115	103	Vdc
REPEATABILITY (maximum shift in operating voltage between successive firings)	100	10	mVdc
VOLTAGE JUMP (maximum sudden jump in operating voltage when operating current is varied slowly over specified range)	5	<1	mVdc
STABILITY (during 500 hours at 150°C)	1.5	0.5	Vdc
DRIFT (maximum voltage change during the one hour Stability Life Test)	200	50	mVdc
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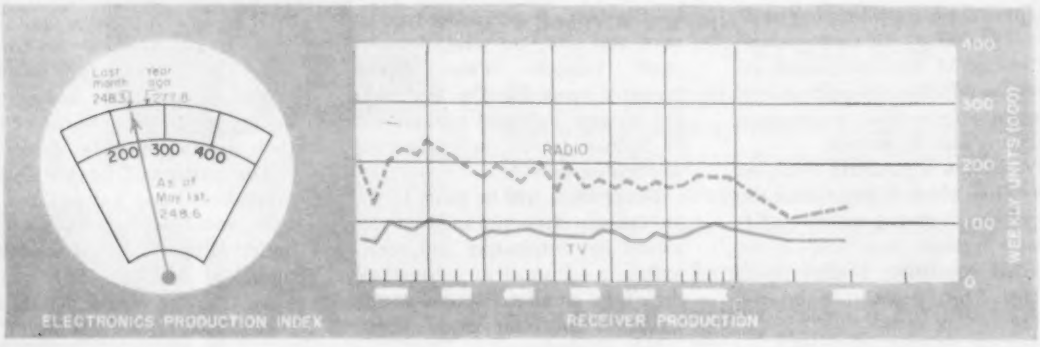
ELECTRONICS NEWSLETTER

AUTOMOBILE MANUFACTURERS are now guardedly admitting that electronic devices may achieve a big breakthrough in 1960 models, with some showing up next year. Some of the devices that may add fuel to the automakers' competitive fire are: electroluminescent dashboard, fuel injector controller, transistor regulator and self-rectifying a-c generator (ELECTRONICS, p 19, June 27). Electronic features are generally expected to be factory-installed and offered on an optional basis at first, although competition could change this. Already, it's understood that Sylvania Electric will supply electroluminescent panels for dashboards of one Big Three luxury class car as standard equipment in 1960; panel will fit behind stencilled plastic dashboards.

SPACE VEHICLE RADIO ANTENNA will be erected for the Defense Department's Advanced Research Projects Agency at Goldstone Test Station, Camp Irwin, Calif. Jet Propulsion Laboratory, the prime contractor, says the multimillion dollar 85-ft diameter antenna is expected to be in operation by the end of this year. ARPA director Johnson declares the antenna will be capable of maintaining communications with space vehicles and represents an initial step in the development of ground equipment for the U.S. lunar probe program. Site at Camp Irwin offers extremely low background noise level, with manmade interference there at a minimum. Just announced is a contract to The Rucker Co., Oakland, Calif., for the antenna's hydraulic drive and control system. Rucker says the remotely controlled system, which is unaffected by weather, will take signals from data processing equipment and rotate the antenna precisely as it locates and tracks satellites or lunar vehicles.

R&D CONTRACTS FOR MINUTEMAN, the Air Force solid-fueled ICBM, have just been announced as follows: guidance system, North American Aviation's Autonetics division; nose cone, Avco; first-stage engine, Thiokol, with limited backup by Aerojet-General; second-stage, Aerojet-General, with a parallel program by Thiokol stressing a different engine case; third-stage, Aerojet-General, with backup by Thiokol contingent upon verification of propellant properties and a program by the Hercules Powder Co. to "thoroughly explore double based propellant potential."

ANTISUBMARINE BLIMP with a load of electronics is being flight-tested by Goodyear Aircraft. The 3-W blimp is one of four the firm is building for the Navy. Some two tons of electronic gear are reportedly in the airship, including a big radar. It is also understood that Goodyear has developed a dacron-type of material that might be used instead of nylon for the envelope of the blimp. Dacron, it is claimed, would allow the craft to support close to four tons of electronic gear.



FIGURES OF THE WEEK

RECEIVER PRODUCTION

(Source: EIA)	July 11, '58	July 4, '58	July 12, '57
Television sets, total	54,343	55,884	65,338
Radio sets, total	103,490	97,205	110,092
Auto sets	43,167	19,741	50,197

STOCK PRICE AVERAGES

Source: Standard & Poor's)	July 16, '58	July 9, '58	July 17, '57
Radio-tv & electronics	49.37	49.14	52.04
Radio broadcasters	62.18	62.58	64.77

FIGURES OF THE YEAR Totals for first five months

	1958	1957	Percent Change
Receiving tube sales	154,136,000	185,847,000	—17.1
Transistor production	14,894,230	8,954,000	+66.3
Cathode-ray tube sales	2,963,741	3,710,646	—20.1
Television set production	1,790,840	2,178,361	—17.8
Radio set production	4,186,869	6,098,951	—31.4
TV set sales	1,927,290	2,420,633	—20.4
Radio set sales (excl. auto)	2,307,610	2,909,548	—20.7

MORE FIGURES NEXT PAGE

WESCON Awaits 30,000

This month's "look ahead" conference offers 20 percent more exhibitors and a new look

LOS ANGELES—WESCON '58—dubbed the "look ahead" conference—this month features fewer technical sessions than last year's conclave but a 20-percent increase in exhibit booths (photo).

The Western Electronic Show and Convention runs from August 19 through 22 in Los Angeles' Ambassador Hotel and Pan Pacific Auditorium. About 30,000 visitors are expected. (Full program, show guide start on p 138).

There are more than 900 booths, and 1.2 million lbs of exhibit equipment which will occupy available 192,000 sq ft during show. Percentage of total electronics industry production capacity to be represented by exhibits is estimated at slightly over 80 percent.

Production equipment occupies a pavillion which is larger than the rest of the show put together. Exhibitors indicate new items to be unveiled constitute a record percentage of total wares to be shown—possibly 35 percent.

Another '58 innovation is a directory listing exhibitors by product. Producers of a particular item will not be together on the floor but will be easy to locate.

Technical program committee for Wescon consists of two members appointed from each major professional group of IRE. Among many highlights promised by committee is a session airing the "airframe vs electronics" controversy on project management.

One recession effect that will be noticed in technical sessions—fewer "razzle-dazzle," speculative-type papers, and more on solid, down-to-earth subjects. Two subjects touched upon for the first time by Wescon technical sessions will be human factors in engineering and writing-speech.

Recognition will be given to the increasingly important industry role played by distributors and representatives. Instead of a breakfast, there'll be an all-day session in the Cocoanut Grove on August 21.

Two men in the news have been selected to address the all-industry and WCEMA luncheons. Maj. Gen. John Medaris will address the former, while the WCEMA group will hear from Brig. Gen. Baron von Schleinitz, German Assistant Defense Minister, and NATO representative for West Germany.

Aviation Center To Test Aids

OPENING last month of National Aviation Facilities Experimental Center is the sign that Airways Modernization Board is ready for action. This facility, formerly the Pomona Naval Air Station near Atlantic City, N. J., was decommissioned from Navy duty just before Independence Day and turned over to AMB.

NAFEC will have a permanent staff of over 200 engineers, technicians and scientists. Ultimately the center will be called in at every stage of development of air traffic control aids. AMB will look to the center for collection of data, for advice on available equipment, and for analyses of how the bits and pieces fit together.

Equally important will be NAFEC's work with industry. Says NAFEC's chief, brisk and wiry USAF Col. William S. Cowart Jr.: "We'll work with manufacturers on equipment and systems design, advise them where we can, then test their gear for them."

The center will be AMB's only experimental and test facility. It's right under one of the country's busiest airlines, close to the SAGE central at McGuire AFB and to one of the big coastal SAGE gap-filler radars. The area has some

TRANSISTOR AND TUBE SALES, MONTHLY

(Source: EIA)	May '58	Apr. '58	May '57
Transistors, units	2,999,198	2,856,234	2,055,000
Transistors, value	$7,250,824	$7,025,547	$5,636,000
Receiving tubes, units	36,540,000	32,582,000	32,836,000
Receiving tubes, value	$31,406,000	$28,788,000	$28,955,000
Picture tubes, units	560,559	590,357	758,328
Picture tubes, value	$11,237,147	$11,591,733	$14,031,519

MILITARY ELECTRONICS BUYING, QUARTERLY

(millions of dollars)	1st quarter, '58	4th quarter, '57	1st quarter, '57
Aircraft	$ 513.3	$ 524.0	$ 495.5
Missiles	245.4	232.8	201.2
Electronics & communications	183.0	214.0	251.0
Research & development	104.8	103.2	111.0
Ships—harbor craft	28.2	27.7	24.2
Combat & support vehicles	.9	.9	7.7
Miscellaneous	5.8	5.2	8.6
	$1081.4	$1107.8	$1099.2

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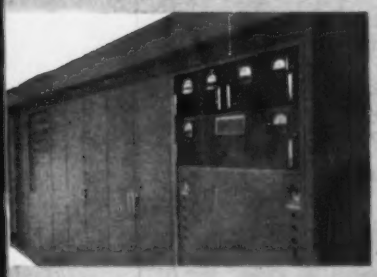
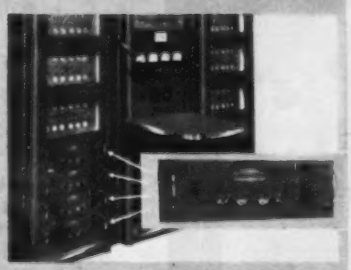


Lambda power supplies are components of IBM's SAGE computer, the world's largest electronic digital computer.



Lambda Com-Pak supplies, with front panel modifications, used by Western Electric to power United States continental air defense system tests.

Standard Lambda power supplies specified by Stromberg-Carlson for multi-million dollar Air Force Digital Computer Intervention and Display System.

Retroactive to all Lambda Power Supplies purchased since 1953

Now Lambda gives you the strongest proof of consistent trouble-free power supply performance ever offered.

The unprecedented five-year guarantee is based on the excellent experience owners of Lambda power supplies have had with their equipment under the most grueling, heavy-duty service.

You are covered not only on new Lambda supplies, but also on all Lambda equipment you have purchased since 1953.

See new Lambda Transistorized Power Supplies at WESCON Show

They will be on display in Booths 842 and 843. You'll also want a close-up view of Lambda's Com-Pak® series, for all needs up to 1.5 amperes. The Com-Pak models are real space savers. They need only 5¼" to 8¾" of front panel height, depending on the model.

Send for latest catalog

Your request, on your company letterhead, brings you complete data on all Lambda power supplies—rack, bench and portable.

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Aerocom's Dual Automatic Radio Beacon

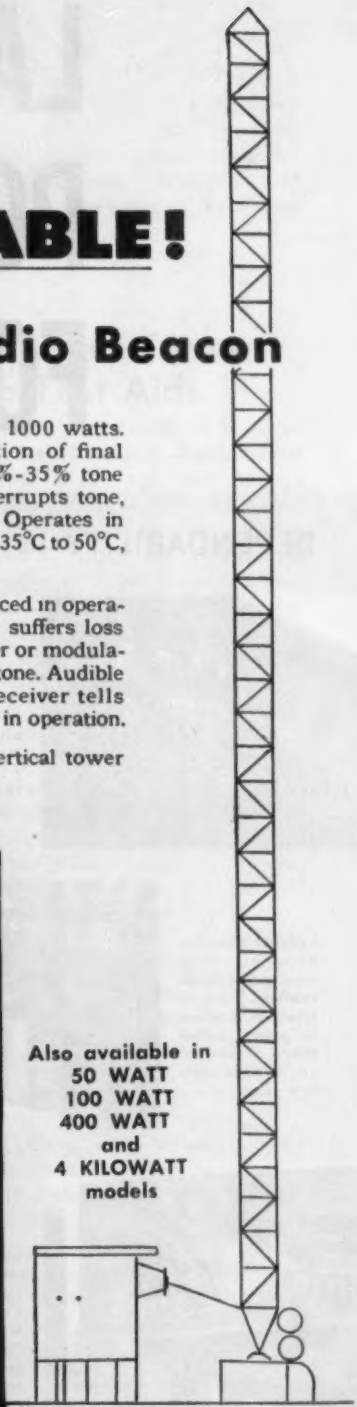
Reliability is built into every part of this dual 1000-watt aerophare unit. Ruggedly constructed and conservatively rated, it provides trouble-free unattended service, and at truly low operating and maintenance cost. It operates in the frequency range 200-415 kcs, using plug-in crystal for desired frequency.

Uses single phase power supply, nominal 220 volts, 50 or 60 cycles. Consists of two 1 kw transmitters with keyer (2 keyers if desired), automatic transfer unit and weatherproof antenna tuner. Each transmitter housed in separate standard rack cabinet, with controls in rack cabinet between the transmitters.

Nominal carrier power is 1000 watts. High level plate modulation of final amplifier is used, giving 30%-35% tone modulation. P-T switch interrupts tone, permitting voice operation. Operates in ambient temperatures from -35°C to 50°C, humidity up to 95%.

Standby transmitter is placed in operation when main transmitter suffers loss (or low level) of carrier power or modulation, or continuous (30 sec.) tone. Audible indication in monitoring receiver tells when standby transmitter is in operation.

Antenna may be either vertical tower or symmetrical T type.



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and
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models

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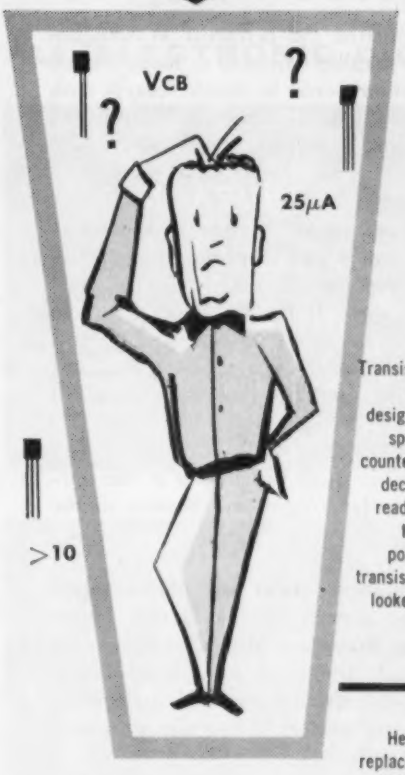
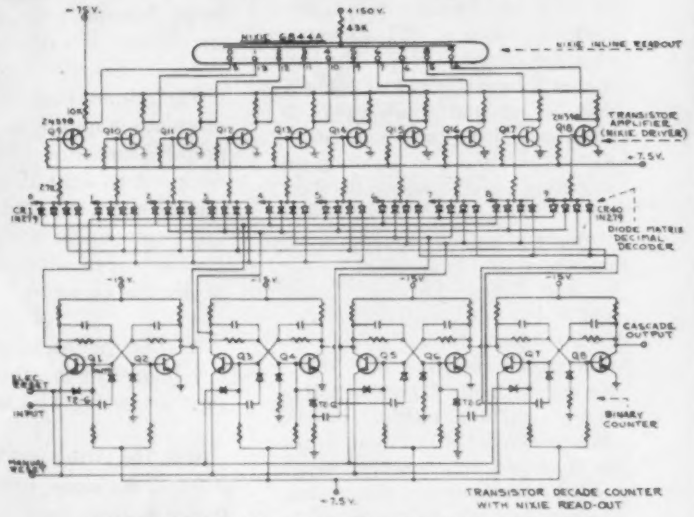
CIRCLE 7 READERS SERVICE CARD→

are you a victim of

ENGINEERING HYSTERISTOR?*

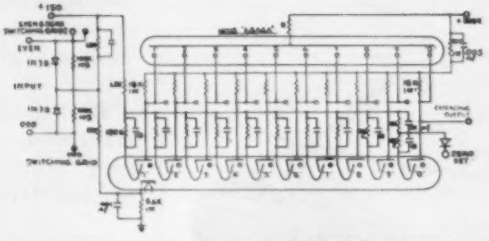


Transistor expert, Bill Binary, designed a high-speed decade counter requiring decimal in-line readout. He did the best job possible (with transistors) and it looked like this:



TRANSISTOR DECADE COUNTER WITH NIXIE READ-OUT

He could have replaced eighteen (18) transistors and forty (40) diodes with one (1) Beam Switching Tube like this:



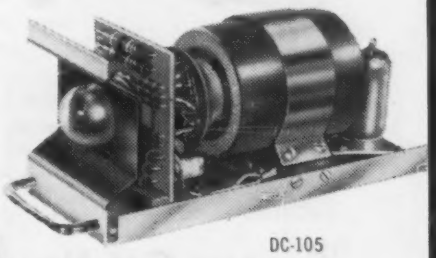
BEAM SWITCHING TUBE DECADE COUNTER WITH NIXIE READ-OUT

* **EPIDEMIC SYMPTOMS:**
HYSTERICAL
TOTAL USE OF TRANSISTORS

ANALYSIS: Transistors like ordinary tubes or cores are essentially binary devices.

REMEDY: Use a decimal component like Beam Switching Tubes to perform a decimal function.

LIVING PROOF:
Burroughs Decade Counter Type DC-105 With Nixie® In-Line Readout operates at 1 MC, has 10 outputs for remote readout or printout and reset time of less than 1 microsecond — **COST $145**



DC-105

YOU SHOULD KNOW ABOUT BEAM SWITCHING TUBES BECAUSE :

A single cathode controls an electron beam to any one of 10 constant current outputs each of which has individual bi-stable beam locking and high impedance switching.

You will find Beam Switching Tubes being used regularly to outperform other components wherever there is: distributing, switching, multiplexing, counting, sampling, coding, timing, gating, matrixing, memory, dividing, decoding, converting, or presetting.

FOR NEW CATALOGUES ON (1) BEAM SWITCHING TUBE, (2) DECADE COUNTERS, (3) NIXIE® ALL-ELECTRONIC IN-LINE INDICATOR TUBE, AND (4) PULSE CONTROL EQUIPMENT.

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WESCON SHOW

Burroughs Corporation

ELECTRONIC TUBE DIVISION

Plainfield, New Jersey

of the fanciest weather available in the states. The nearby Atlantic will be used as a down-range extension for much of the experimental flying.

NAFEC is already in operation, farming out any work that it isn't yet equipped to do. AMB plans to spend a lot of money to put the center in business, $12 million is allocated for fiscal 1959. The runways will be extended to accommodate big jets and a fully equipped electronics laboratory will go in first. Cowart is also planning on a space-position range—"the best one we can get, so that we have a standard to test against." He's eyeing the raydist-type ranges at Eglin and Patrick AFBs in Florida and at Point Mugu, Calif.

AMB plans to put in a large-scale digital computer at NAFEC for use by both Cowart's testing groups and the systems analysis directorate of AMB. Cowart hopes to hook his space-position range into the computer and process data derived during evaluation runs directly in real time.

'Copters Get New Electronic Aid

LATEST STEP toward taming the once hard-to-manage helicopter is Sikorsky's tether which allows a man on ground to walk a five-ton Army H-34 around by a string like a toy balloon (photo).

To put the tether into operation, pilot brings his helicopter to a

WASHINGTON OUTLOOK

THE MIDDLE EAST CRISIS has accentuated the perennial Washington debate over U.S. preparedness for a so-called brushfire or local, limited war. Presumably such a limited action would be fought largely with conventional weapons or with tactical nuclear arms only. It would boost demand for vehicular communications, equipment for tactical aircraft and missile systems such as Lacrosse, Dart and Pershing.

The administration's basic policy is that the present U.S. military machine—despite recent cutbacks in armed forces and the lower budget priority for arms and equipment for limited warfare—is still well equipped to fight the brushfire-type war. If the time ever comes to commit more than the ground forces and tactical air and naval support forces now in the field, the conflict will have developed into an all-out nuclear war in which strategic air forces and area defense systems will be decisive elements.

Against this backdrop, you can see no sharp turnaround in the military budget or in other key defense policies right now because of the situation in the Middle East.

Still, the Army and other people unhappy about past administration defense decisions will jump on the present crisis as a new opportunity to argue the need for boosting production of tactical planes and support equipment and weapons and equipment for ground forces. On this score, the Joint Chiefs of Staff ordered a special study some months back on the size and battle readiness of U.S. forces to fight a small war—with special attention on airlift.

Short-range, however, most Pentagon officials knock down talk of a major reappraisal of arms production plans because of the Middle East crisis. There's nothing we could do fast enough that could have any significant impact on our capabilities, they say.

- **The Middle East crisis** has put the spotlight on Washington's industrial mobilization plans.

  The government already has authority to allocate materials and components to defense producers. Suppliers are now required to give defense-rated orders special priority. Under present industrial market conditions, however, this preference is really academic. The government also has limited power to allocate material to civilian consumers and to restrict production of nonmilitary hard goods. These authorities are exercised by the Commerce Dept.'s Business and Defense Services Administration under policies set by the Office of Defense and Civilian Mobilization.

The Army and the Navy have tentative mobilization production schedules for a war emergency. Thousands of plants are lined up to expand or convert to manufacture of specified military items. The Air Force has made plans with only selected contractors already in active production to step up output of tactical planes and support equipment in case of a limited war or to speed production of bombers in case of attack on continental U.S.

ALL-ELECTRONIC DIGITAL VOLTMETER...ONLY $960

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MILLIVOLT TO
KILOVOLT WITH
0.1% ACCURACY

no moving parts
digital in-line readout
70 millisecond conversion time
adjustable display time
direct voltage conversion

Here at last is a portable all-electronic digital voltmeter that measures DC voltages from .001 to 1000 volts with 0.1% accuracy. In less than 1/10 of a second the measured voltage is presented in clear numerical form on a digital in-line readout that even unskilled personnel can read quickly and accurately, with little possibility of error. *Direct* voltage measurement by successive approximation provides accuracy and sensitivity previously obtainable only in the delicate, complex and expensive instruments. Extremely stable operation – continuous calibration against an internal reference.

The low price of the Model 801 allows you to put one on every bench. Its accuracy and reliability are assured by KIN TEL's years of design and manufacturing experience . . . experience gained in the manufacture of more than 10,000 precision electronic instruments.

BRIEF SPECIFICATIONS (model 801)

Ranges....0.000 to 1.599; 00.00 to 15.99; 000.0 to 159.9; 0000. to 1000 volts (manual ranging and polarity)
Accuracy....0.1% of full scale
Readout....4 digits plus decimal point
Input Impedance....20,000 ohms per volt*
Conversion Rate....10 per second
Conversion Time....approximately 70 milliseconds
Display Time....Adjustable from approximately .1 second to infinity (plus push-button *read once* control)
Dimensions....11" high x 7½" wide x 20" deep
Power Requirements....105 to 125 volts, 60 cycle AC, 180 watts

*The Model 802 provides 10 megohms input impedance. Price $1190. In other special models the binary coded decimal and decimal outputs are externally available to permit use as an analog to digital converter.

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WESCON SHOW—BOOTHS 1413, 1414, 1458, 1459

hover about 50 ft off ground. He then trims the ship with the Sikorsky Automatic Stabilization Equipment (ASE), engages the tether coupler, an electronic sensing device also company-developed, and lowers the cable to the man on ground. Pilot then takes hands and feet off controls, sits back and enjoys the show.

One end of the tether is connected to a sensing unit attached to the rescue hoist mount above the cabin door. When the pilot engages the coupler, two lights on bottom of sensing device flash on, indicating to the ground that tether is alive. When ground man moves tether in any direction, as well as up or down, the sensing device detects the motion and feeds the signals to the coupler. The coupler, in turn, transmits the signals to the ASE which automatically repositions helicopter to desired height and location and maintains the ship's stability.

Applications of the device are numerous: guiding a 'copter over cargo at night to make a pickup; placing utility poles in holes; lowering sections of high-tension towers; laying temporary bridges; loading and unloading trucks; and landing on heli-platforms on ships.

New Gear Makes 3-D X-Ray Films

THREE-D X-RAY motion picture studies of the heart can now be made at Stanford Medical School with new apparatus installed at a cost of $100,000.

Two image intensifiers at right angles to each other are used. They are said to make the fluoroscopic image 100 times brighter on their circular 11-in. screens, thus lowering the amount of x-rays needed. X-rays beamed through patient directly into image intensifiers produce images caught on specially processed 35-mm motion picture film.

An opaque material, injected into the heart chamber, is recorded as it moves through the heart, lungs and great vessels. Two film strips showing the same motion from different angles can be projected together to give 3-D effect.

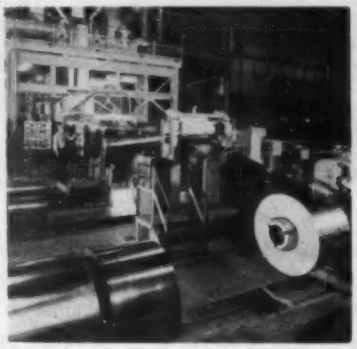
MILITARY ELECTRONICS

• **Total contract** to date for USAF's Atlas ICBM amounts to $314.8 million. Formal confirmation of Air Materiel Command's earlier letter contract with Convair covers past and present research, development and design of both missile and supporting equipment.

• **Management, services** and supplies necessary to maintain and operate the 3,100 mi White Alice communications system (tropospheric scatter) in Alaska are expected to cost $17,679,122 during fiscal year 1959. Contractor for the work, Federal Electric, also maintains and operates DEW Line, the 3,000 mi radar chain that stretches from northwestern Alaska to the east coast of Baffin Island. White Alice provides communications to a number of DEW Line stations located in Alaska.

• **Air Defense Command's** radar target simulators (AN/GPS-T2) will soon be equipped with a new gadget that simulates jamming signals from enemy aircraft and missiles. The equipment, to be produced by Sylvania, is adaptable to all ADC search radars. Though dollar amount was not released, contract status of two other Sylvania ecm projects are: $54 million to date for the B-58; and $5.6 million in subcontract work for Sperry on the B-52.

• **US-IGY rocket firings** by July 1 totaled 116 from six sites, two of them shipborne operations. Highest known altitude reached was 160 mi. Most rockets carry radio Doppler (DOVAP) tracking beacons for telemetry and tracking. Errors in altitude of less than 100 ft at rocket peak and in velocities of less than one ft per second are commonplace.



Feedback Runs Tinplate Line

COILS OF STEEL entering new electrolytic tinning line (left photo) at U. S. Steel's Pittsburgh, Calif., plant are now guided through the process by a variety of electronic control equipment.

Processing, at speeds up to 1,250 feet a minute, is regulated and synchronized by automatic closed-loop systems. Included are modulated loop controls, both magnetic and photoelectric, and other regulators which govern speed, edge position, tension, temperature and plating current.

The line employs pin-hole detectors, radiation gages for measuring steel and coating thickness, flow line indicators, reflectivity devices for surface inspection and sheet classifying equipment. Memory devices cause cut pieces of tinplate to be classified according to quality.

Nerve center for control system flanks the cleaning and coating tanks (right photo). Line, which

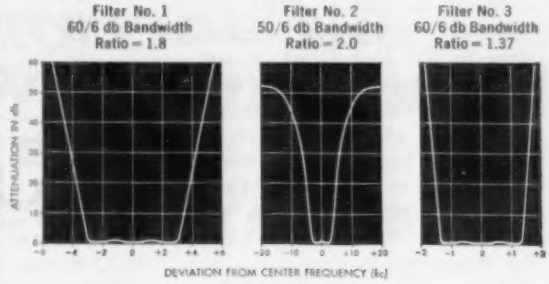
new performance levels set by Hughes precision crystal filters

Hughes Products now offers high performance crystal filters previously available only for special military developmental contracts and Hughes-built systems. Utilizing unique design and advanced manufacturing techniques, these Hughes crystal filters provide a degree of performance previously unattainable.

With center frequencies of 30 kc to 30 mc and fractional bandwidths of 0.01% to 6%, these crystal filters have seven distinct advantages:

1. **High frequency filtering**
2. **High selectivity**
3. **Low passband ripple**
4. **Low insertion loss**
5. **Small size and weight**
6. **Excellent temperature stability**
7. **Excellent shock and vibration stability**

SPECIFIC PERFORMANCE CHARACTERISTICS FOR TYPICAL FILTERS



	No. 1	No. 2	No. 3
Center Frequency	1.75 mc	10 mc	1.75 mc
6 db Bandwidth	6 kc	70 kc	2.7 kc
Maximum Insertion Loss	6 db	< 2 db	6 db
Maximum Passband Ripple	≐ 1 db	< 0.25 db	≐ 1 db
Stopband Attenuation	> 60 db	> 50 db	> 60 db

For further information please write HUGHES PRODUCTS, Crystal Filters, *International Airport Station, Los Angeles 45, Calif.*

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HUGHES PRODUCTS

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uses germanium rectifiers, has a plating capacity of approximately 100,000 amperes. Current is kept proportional to line speed.

Increased business seen for mobile radio makers as . . .

Exec Planes Use Flight Phones

AIRPLANE passengers above the Great Lakes area are making about 400 phone calls a month to homes and offices by a new AT&T system.

The system, based on combined use of radio and wire communication, is expected to create a new group of sales prospects for mobile transmitter manufacturers if long-range plans go through. Potential market area will be among more than 60,000 private and 1,500 commercial airplanes.

Short-term goal of AT&T is a 400-mile wide corridor from Chicago to the East Coast. System growth will probably start from present installations in the Chicago-Detroit area, where trials have been in progress since last September, and extend to Pittsburgh, Washington and New York. Calls will range in price from $1.50 to $5.25 for three minutes, depending on distance. Experimental airborne transmitters have been satisfactorily performing in the tests. Most of the 20 airplanes participating in tests are company executive planes. Northwest and Capitol airlines have also participated in the experiments.

Current operations are on channels borrowed from mobile land users. AT&T hopes to obtain other space spectrum when system acceptance comes about.

FINANCIAL ROUNDUP

• **Early reports** of second quarter operating results show profits improving over the first quarter, but trailing last year. **General Electric** reports net profits of $54.2 million or 62 cents a share on sales of $1.014 billion for the April-June quarter. Profits rose 10 percent and sales five percent from the first three months of the year. Compared with second quarter of 1957, firm's profits were down 15 percent; sales were off five percent.

For the first six months GE earnings were $103.4 million, or $1.18 per share, 19 percent less than last year. Sales were $1.979 billion, seven percent below the record 1957 period.

• **Cohu Electronics,** San Diego, Calif., claims second quarter profits have about balanced out first quarter losses. It expects to report six months profits that will be a hair above or below the break-even point. The San Diego firm had a net income of $222,389, equal to 28 cents a share, in the first half of 1957.

• **Tempo of new financing** is increasing. **Dayton Aviation & Radio,** Dayton, Ohio, issues 500,000 shares of stock at $1 per share. The Ohio communication and navigational equipment manufacturer will use net proceeds of $440,000 for additional inventories, equipment and facilities to finance new products, and new government contracts. It may also pay off some of the $140,000 owed to the Commercial Credit Corp. (ELECTRONICS, p 6, June 27).

• **Cook Electric,** Chicago, Ill., privately places $2 million of six percent preferred stock with an institution.

• **Jetronic Industries,** Philadelphia, Pa., issues 130,000 shares of common stock at $3.75. The firm makes special and general purpose test instruments and underwater communications equipment. Proceeds will be used for R&D and working capital. Underwriters are Charles Plohn & Co. and Mortimer R. Burnside & Co., both of New York City. Underwriting commission is 20 percent or 75¢ per share.

• **Burroughs Corp.** issues $25 million of sinking fund debentures due July 1, 1983, and 550,000 shares of $5 par value stock. The stock has recently been selling at 33-34 on the NYSE. It will be offered to stockholders at rate of one additional share for each 11 shares held. Proceeds will be used to retire $18,074,000 of installment notes and to reduce current debts to banks. Lehman Brothers of New York City will head the underwriting group.

Seek New F-M Radio Uses

BROADCASTERS are being asked by FCC to take a hard look at f-m radio to see what possible additional uses can be made of multiplexed f-m signals.

Commission invites broadcasters and other interested parties to file comment by Sept. 15.

Multiplexing goes back to March of 1955 when FCC changed the rules to allow commercial f-m broadcasters to engage in certain types of non-broadcast activities. Commission says this was done to give f-m operators a financial assist.

Since then, interest in other uses of multiplexing on f-m stations has grown. Some suggestions currently simmering include price quotations, facsimile, stock market reports, paging services and traffic light control.

Stereophonic broadcasting has been proposed both as an improved aural broadcasting system and as a type of subsidiary communication similar to that which may now be offered on a subscription basis.

A spokesman for FCC says the question of additional uses of multi-

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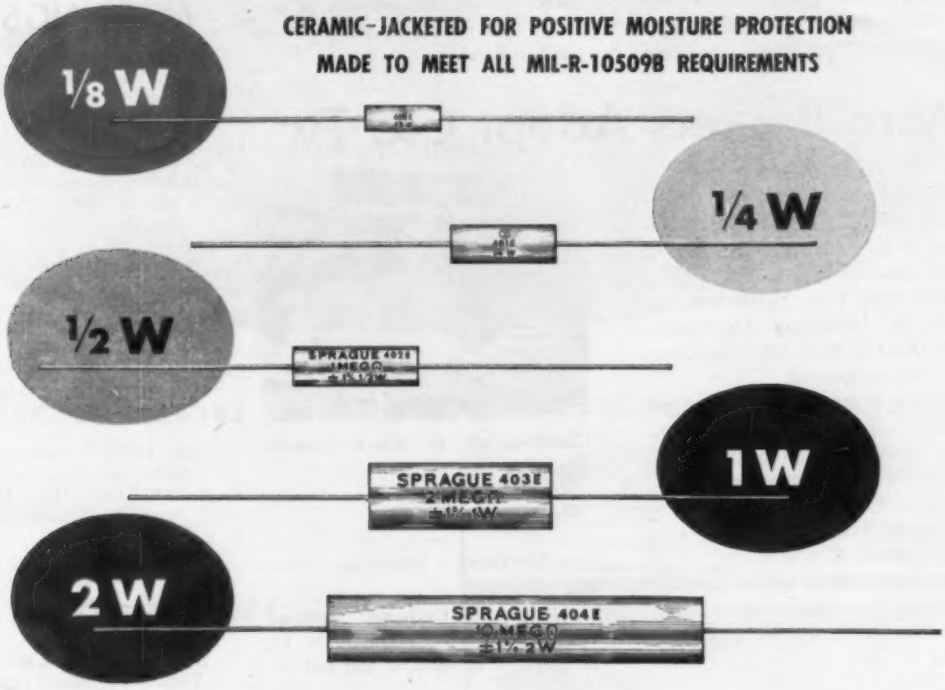

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plexing by f-m broadcasters should be reexamined to determine, after three years' experience, whether these activities are feasible, appropriate and should be permitted in the f-m band.

More Brokers Adopt C-C Tv

TWO MORE investment firms are now using closed-circuit tv. One is Bache and Co. of New York, another is E. F. Hutton and Co. of San Francisco.

The New York installation was made by Hallamore Electronics. The West Coast installation uses Kin Tel equipment.

Both systems consist of a vidicon pickup camera focussed on an optically magnified ticker tape, and a number of monitors located throughout the offices.

New York Stock Exchange tells ELECTRONICS that a memo to all member companies advises that the Exchange is ready to receive applications for permission to use closed-circuit tv. Reports are that a number of investment houses are "showing great interest".

The Curb Exchange member firm of McDonald Holman, N. Y., installed tv equipment last fall.

Closed-circuit tv relays optically magnified figures

Refreshing scene for these summer days shows technician carrying test gear to repeater station atop western Montana mountain during final checks on new 350-mile microwave radio network

Microwave Licks Rugged Terrain

NEW MICROWAVE telephone system announced recently spans 350 miles, covering sections of Montana, Idaho and Washington. The network cost more than $1 million.

Lenkurt Electric Company, which supplied the equipment to General Telephone Company of the Northwest, reports that work crews sometimes had to use snowcats to reach some locations.

Much of the work was done in high altitudes, the highest being 6,200-ft Mt. Pinkham in western Montana. Snowdrifts of 20 to 30 feet are common in this area. Temperature drops as low as 45 degrees below zero.

The system contains nine terminals, seven repeaters. It is designed to carry a peak load of 120 voice channels. Many of the circuits are for the Army's SAGE network.

Airline Orders $16 Million Unit

A $16 MILLION interconnected electronic data processing system to handle passenger reservations has just been ordered by United Airlines.

The system ordered from The Teleregister Corp., Stamford, Conn., will use three Telefiles, large scale stored-program data processors designed to operate as on- or off-line gear for general problems.

Stanford Research Institute made a three-year study of United's needs before the airline picked the system which will service 2,500 ticket sales agents in 208 cities. System can process all airline's flights one year in advance.

MEETINGS AHEAD

Aug. 1-3: Texas Electronic Clinic and Fair, Statler-Hilton Hotel, Dallas, Texas.

Aug. 6-8: Special Tech. Conf. on Nonlinear Magnetics and Magnetic Amplifiers, AIEE, Hotel Statler, Los Angeles.

Aug. 13-15: Conf. on Electronics Standards and Measurements, AIEE, IEE, NBC, National Bureau of Standards Labs., Boulder, Colo.

Aug. 13-15: Seventh Annual Conf. on Industrial Applications of X-ray Analysis, Denver, Colo.

Aug. 19-22: Western Electronic Show and Convention, Los Angeles, Calif., WESCON, IRE, WCEMA, Pan Pacific Auditorium, Ambassador Hotel, L. A.

Aug. 19-22: Pacific General Meeting, AIEE, Senator Hotel, Sacramento, Calif.

Aug. 26-Sept. 6: British National Radio Show, Radio Industry Council, Earls Court, London.

Sept. 10-12: Tube Techniques, Fourth National Conf., Advisory Group on Electron Tubes, OSD, Western Union Auditorium, N. Y. C.

Sept. 12-13: Communications Conf., IRE, Sheraton Montrose Hotel, Cedar Rapids, Iowa.

Sept. 15-19: Thirteenth Annual Instrument-Automation Conf. and Exhibit, ISA, Philadelphia Convention Hall, Pa.

Sept. 18-19: National Assoc. of Broadcasters, Fall Conf., Buena Vista Hotel, Biloxi, Miss.

Sept. 22-24: National Symposium on Telemetering, Americana Hotel, Miami Beach, and Patrick Air Force Base (Sept. 25).

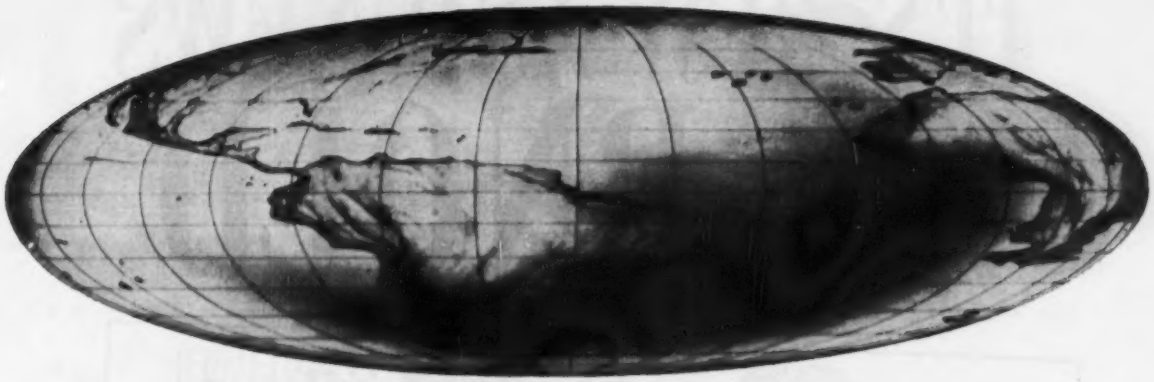
Oct. 13-15: National Electronics Conf., 14th Annual, Hotel Sherman, Chicago.

Oct. 20-21: Aero. Communications Symposium, Fourth National, PGCS, Hotel Utica, Utica, New York.

Oct. 20-21: USA National Committee, URSI Fall Meeting, Penn State Univ., University Park, Pa.

Oct. 27-28: Radio Fall Meeting, Electronics Industries Assoc., Sheraton Hotel, Rochester, N. Y.

Oct. 27-29: East Coast Aero. & Nav. Elec. Conf., Baltimore Hotel and 7th Reg. Armory, Baltimore, Md.



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Constantin has long been noted in the electrical and electronic industries for its rigid inspection of all parts, from start to finish. They have pioneered in unique and difficult designs in such diversified items as multi-headers, all-in-one assemblies, transistor mounts, single terminals, end seals, crystal mounts, and other superior fabrications.

Constantin's experienced staff of design engineers are ready to help you with any glass-to-metal sealing problem. Write today for complete information.

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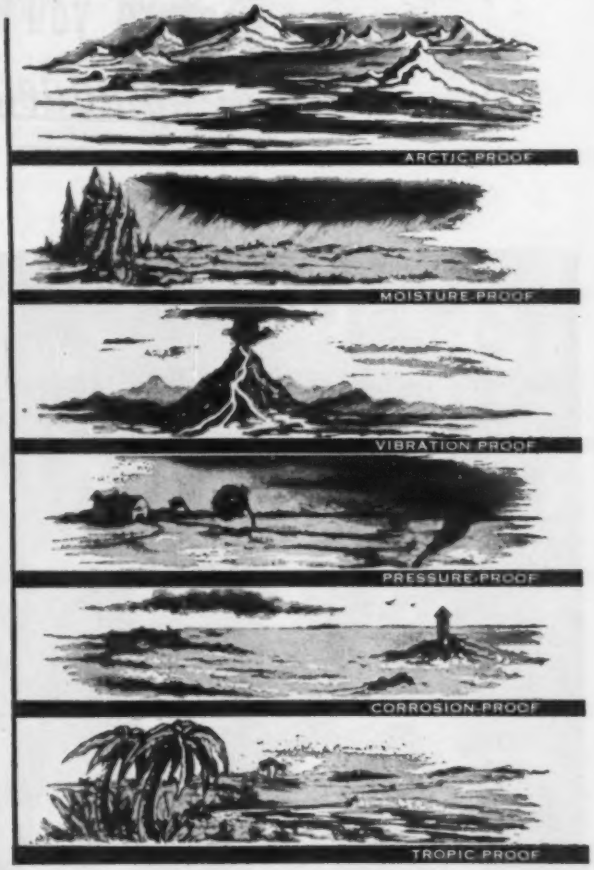
WESCON SHOW

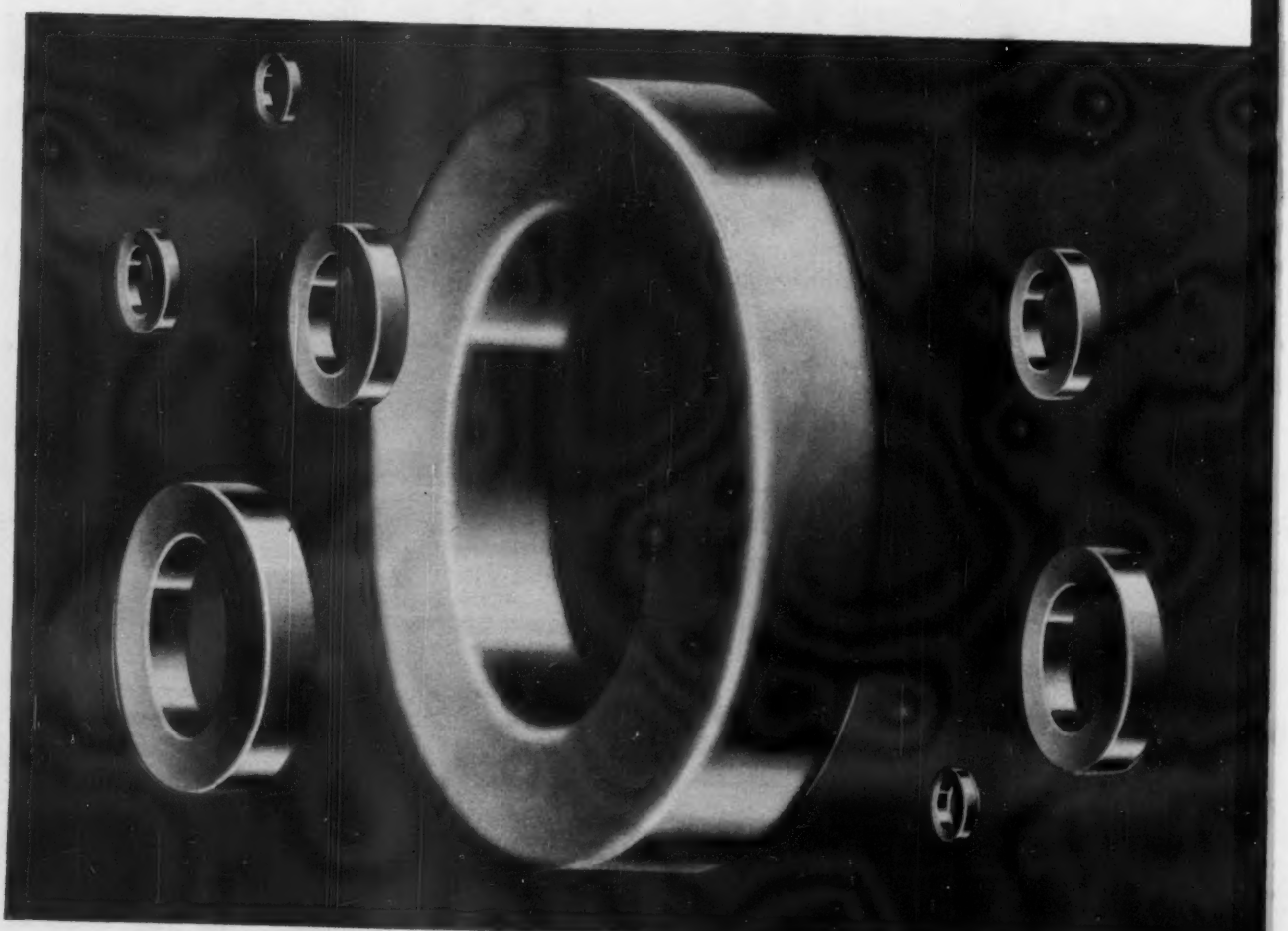


L. L. Constantin & Co. **MANUFACTURING ENGINEERS**

Route 46, Lodi, N. J. 187 Sargent Ave., Clifton, N. J. 5th & Capitol Sts., Saddle Brook, N. J.

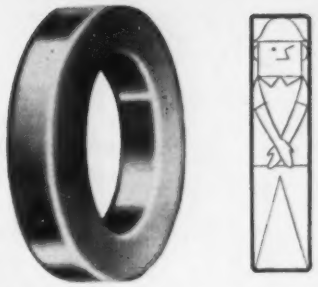
IT'S NEW AND NEWS from ARNOLD

Arnold Tape-Wound Cores now offer you every feature you've been looking for ...at no added cost to you



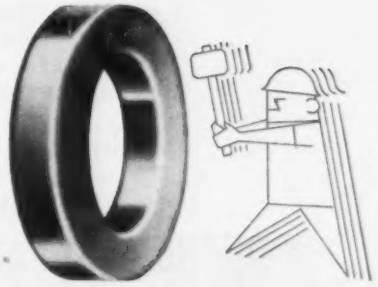
1 NEW COMPACTNESS in Aluminum-cased Cores

Now you can build your designs around the last word in improved tape cores of high-permeability materials. Arnold 6T Cores incorporate a new type of aluminum core box construction, with overall dimensions smaller than older types of aluminum cases, and comparable in size with ordinary plastic-cased cores. *Result:* along with the distortion-free strength of the aluminum case, that resists winding stresses, you now get the compactness and miniaturization possibilities you've wanted.



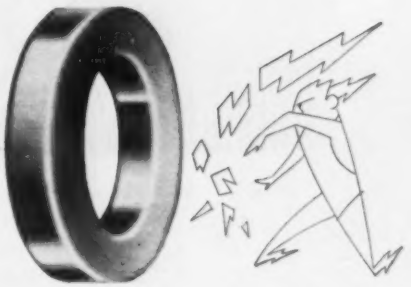
2 HERMETICALLY SEALED, with Built-in Protection against Shock and Vibration

Magnetic properties of Arnold 6T Cores have the most complete protection available on the market. The cores are surrounded by an inert shock absorbent inside the cases, and then hermetically sealed. your best assurance of trouble-free performance, a strong consideration where the service involves long periods of standby. Inherent in the design, of course, is the further guarantee that you can vacuum-impregnate your coils.



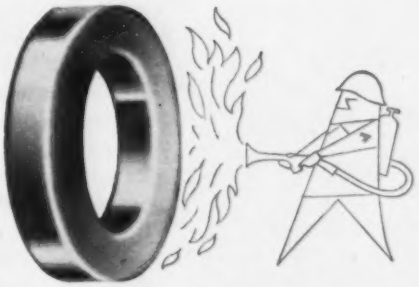
3 1000-VOLT BREAKDOWN GUARANTEED!

The revolutionary new type of core box construction developed for Arnold 6T Tape Cores employs a strong, inert covering for which 1000-volt breakdown is guaranteed. This covering possesses a hard gloss finish, and gives a suitable radius on all corners. The elimination of sharp corners insures against cutting through the insulation of the winding wire. The hard, non-cold-flowing finish protects against the wire cutting through the case covering, a double guarantee against shorted wiring.



4 MEETS MILITARY "SPECS" for Operating Temperatures and Temperature Rise

Arnold's new type of hermetically-sealed aluminum core box construction fully meets the requirements of military specifications Mil-T-5383 or Mil-T-7210, wherever applicable. This involves a positive guarantee that the case construction will withstand ambient temperatures to 170°C, and a 25°C temperature rise.



Arnold 6T Tape Cores will be available in all standard sizes, and special sizes may be made to order... all guaranteed for size, hermetic seal, dielectric strength and temperature of operation.

WSW 7250

THE ARNOLD ENGINEERING COMPANY

Main Office & Plant: Marengo, Illinois

Ropath Pacific Division Plant: 641 East 61st Street, Los Angeles, Calif.

District Sales Offices:

Boston: 49 Waltham St., Lexington Los Angeles: 3450 Wilshire Blvd.

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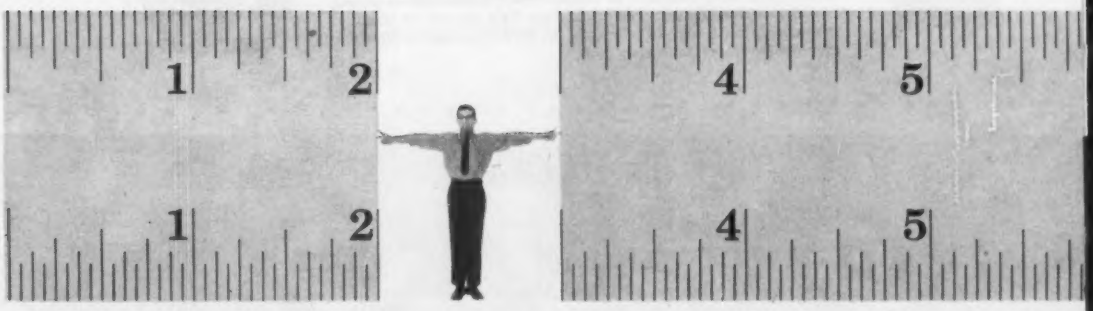

Openings at all levels
exist for engineers qualified
in the following fields:
Digital computers
Analogue computers
Radar simulators
Automatic check-out equipment
Complex electronic simulators
Optical systems
Electronic packaging

Openings also exist at
our main plant,
Binghamton, New York.
Information forwarded
upon request

One in a million

the engineers
the company
the opportunity

When a smoothly functioning team of engineers is employed by a company that offers the perfect *creative* opportunity, the stage is set for the possibility of that rare phenomenon—a major technical break-through.

For example: Exact tolerances to *one-millionth* of an inch are now a necessity rather than a scientific wonder. To meet this requirement, a group of engineers at Link Aviation, Inc., developed the Link Fringecount micrometer, an exciting achievement in metrology, (the science of measurement) thus breaking through another barrier. The Fringecount is the only semi-automatic instrument using the wavelength of light as its reference, capable of making *direct*—not comparative—absolute measurements to one-millionth part of an inch.

The Fringecount is but one of many outstanding engineering achievements emerging from this truly creative atmosphere. At Link Aviation, pioneers of flight simulation, this atmosphere is in outstanding evidence. Greatly expanded research and development activity at Link's Laboratories in Palo Alto, California , has lent an urgency to the search for these *one-in-a-million* engineers.

Here are a few special advantages in joining Link. If you intend to continue your advanced technical study, you can benefit from the Honors Cooperative Program that provides advanced study, under regular university curriculum with all tuition expenses paid by Link.

In addition to providing you with an ideal atmosphere in which to work and an enviable academic program to advance your studies, Link supplies all employee benefits associated with the most advanced management practices, such as fine pay and generous hospital, health and retirement benefits.

And most important: management men are engineers. They understand your work and point of view. This kind of administration provides engineering thinking right up to policy level.

Accept this *one-in-a-million* opportunity now!

for appointment
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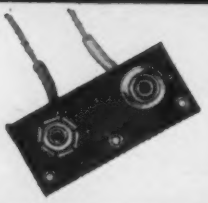
Mayfair Hotel
HUbbard 3-6999

LINK — GPE — GENERAL PRECISION EQUIPMENT CORPORATION

Write: Mr. J. D. Larko
Link Aviation, Inc.
P.O. Box 1318
Palo Alto, California

Link Aviation, Inc., Binghamton, New York

Ucinite Electrical Assemblies



BATTERY CONNECTORS

Wired snap-on units for use with batteries equipped with United-Carr electrical snap fasteners. Wiring to customer's specifications.

BANANA PINS

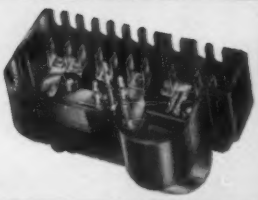
Four sizes of plugs with one-piece beryllium copper springs. Adaptable mounting ends in threaded, staking, or solder lug types. Similar Mating Jacks also available.

STAMPED CIRCUITS

"Printed circuitry" by a stamping process free of electrolytic contamination. High precision and consistent registration.

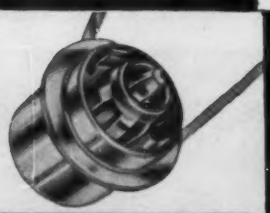
PRINTED CIRCUIT CONNECTORS

Unique torsion-bar contacts provide consistent performance unaffected by repeated insertions of maximum and minimum tolerance boards. Available in 22, 18, 15 and 10 contact sizes.



SPECIAL ASSEMBLIES

Stamped circuits, molded housings, special contacts custom designed in a complete package to fit the application.

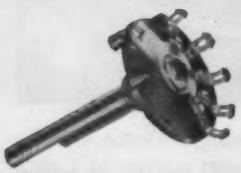


MAGNETRON CONNECTORS

For heater and heater cathode terminals of magnetrons. Available in many variations to answer specific needs.

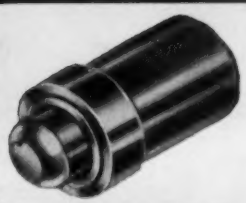
"PK" MOLDED SWITCH

Single wafer rotary switches in rugged molded construction. Economical, durable. Single pole, two or three position.



SNAP SWITCHES

Precision, momentary contact push-button switches. Small and dependable. Several circuit arrangements. Water tight version shown.



TEST JACK

Ucinite's quality jack for .080 probes. Beryllium copper contacts. Nylon insulation in colors. Metal shell for firm dependable mounting.

VIBRATION ISOLATORS

Equiflex 11 to 1 ratio metal mounts ensure long life, fit small spaces, can be used in any direction. Three sizes, cup or plate mountings.

METAL STAMPINGS

Volume production in Metal stampings. Years of engineering and tooling skill available to solve your particular problem.

ELECTRICAL ASSEMBLIES
Ucinite
RADIO AND AUTOMOTIVE

With years of specialized experience in the electronics field and complete facilities for the volume production of small metal stampings as well as the assembly of metal to plastic and ceramic components, Ucinite is fully equipped to supply you with special electrical parts and assemblies...designed, assembled, wired and marked to your specifications. For complete design, engineering and production service, call your nearest Ucinite field engineer.

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DIVISION OF UNITED-CARR FASTENER CORP.

Newtonville 60, Massachusetts

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CUSTOM-DESIGNED AND MASS PRODUCED TO YOUR PARTICULAR REQUIREMENTS

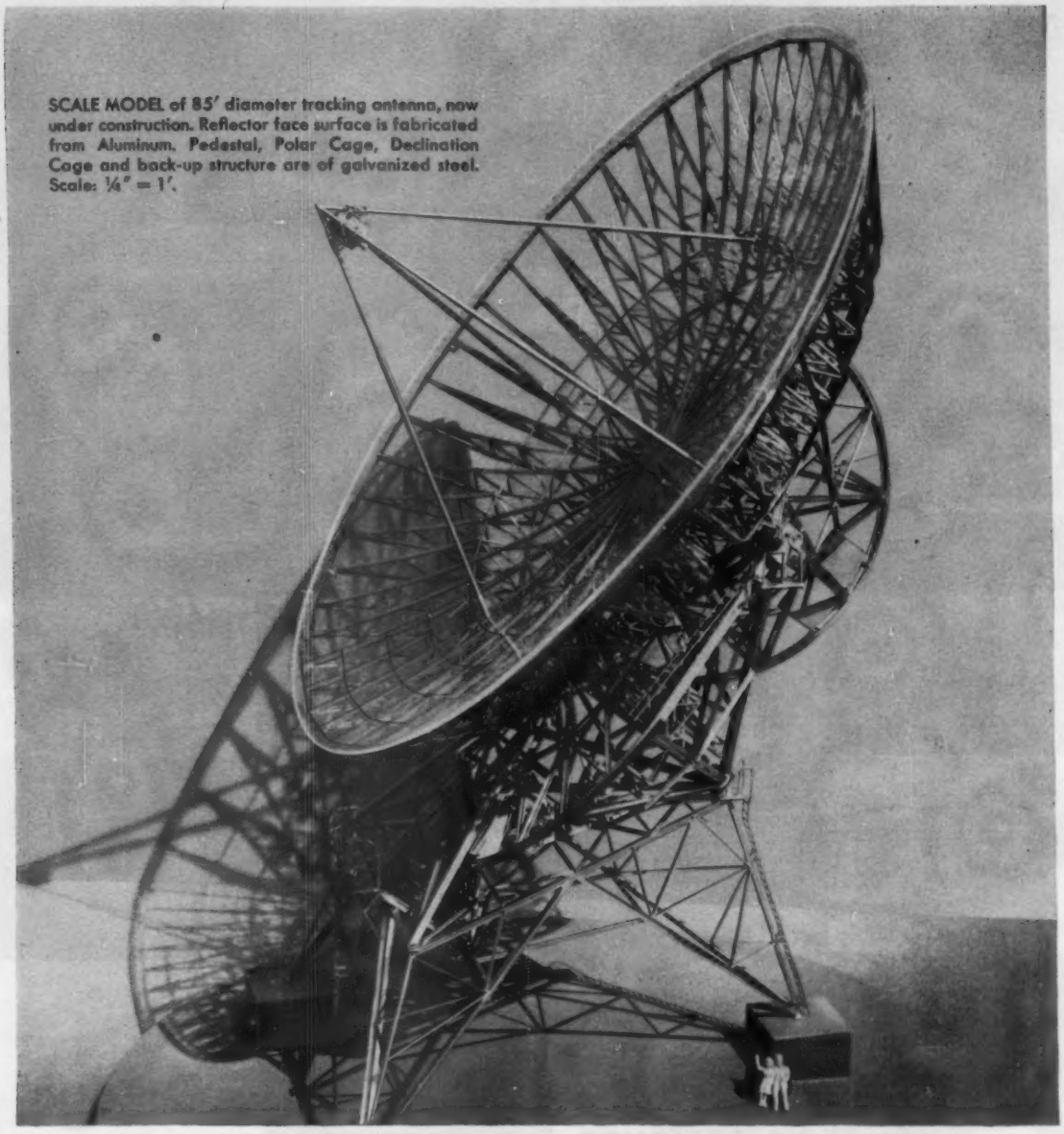
Dot plug buttons were originally used in automobiles to fill spaces on standard models which, on de luxe models would be occupied by such extras as cigarette lighters, radio controls and so on. They are now also widely used as lenses for indicator lights and as identification buttons on instrument and control panels of all kinds.

Available in clear or colored plastics... brass or steel in all standard finishes... embossed and enamel-filled or molded to show company insignia or other identification symbols . . . Dot plug buttons snap into place and stay where they're put even under conditions of extreme vibration. Yet they can be removed and replaced repeatedly without damage.

CARR FASTENER COMPANY

DIVISION OF UNITED-CARR FASTENER CORPORATION 31 Ames Street, Cambridge 42, Massachusetts

MAKERS OF DOT FASTENERS



SCALE MODEL of 85′ diameter tracking antenna, now under construction. Reflector face surface is fabricated from Aluminum. Pedestal, Polar Cage, Declination Cage and back-up structure are of galvanized steel. Scale: ¼″ = 1′.

New Blaw-Knox 85′ Diameter Tracking Antenna

This newest Blaw-Knox 85′ Diameter Tracking Antenna will be part of a telemetering operation connected with missile and satellite development.

Its design is fully determinate. All structural members of the assembly are analyzed for stress and deflection before fabrication. Coupled with shop fabrication and field erection to rigidly accurate tolerances, it is capable of the highest gain, with a minimum of distortions or aberrations.

The entire drive system embodies such critical design requirements as infinitely variable movement with negligible creep or overrun for tracking. The slewing drives are capable of the extremely rapid acceleration and deceleration necessary to focus on supersonic targets.

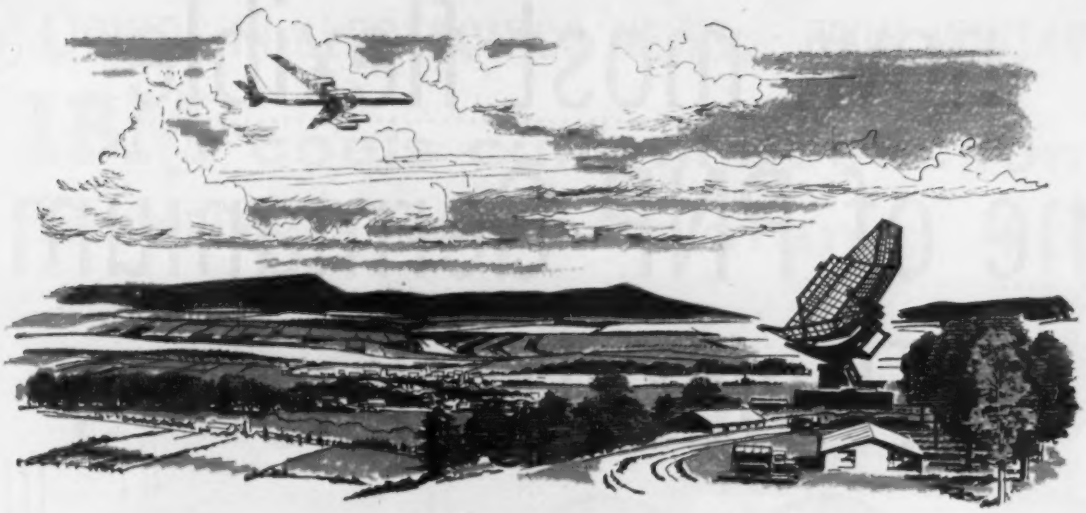
Pioneering like this is the latest step in a long series of Blaw-Knox developments. Such milestones as the Guyed Vertical Radiator design in AM radio, the first radar antenna used to bounce signals off the moon, and the Tropospheric Scatter Antenna for over-the-horizon television have marked Blaw-Knox as a world leader in advanced design, fabrication and erection techniques.

Blaw-Knox welcomes the opportunity to translate your most advanced concepts into highly reliable operating equipment. Contact the Antenna Group.

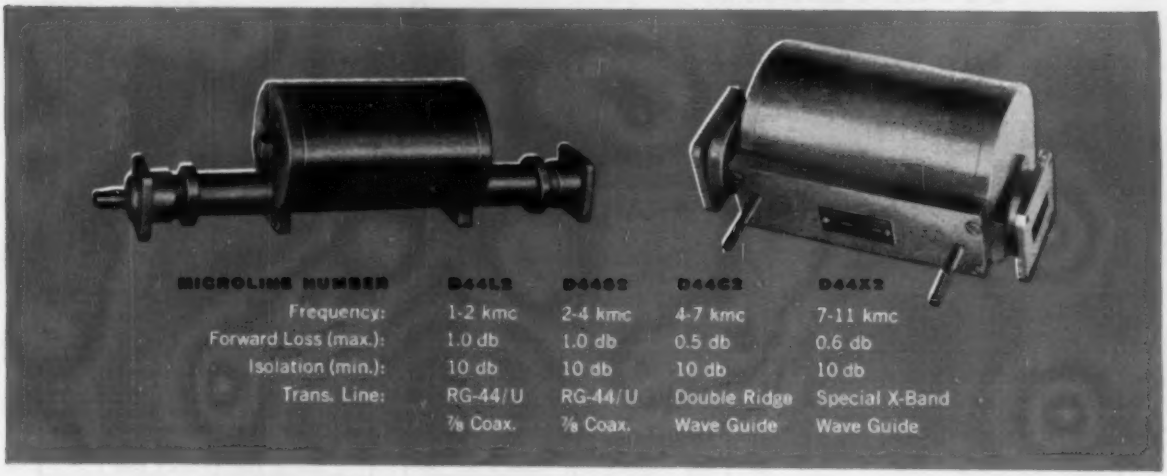
Antennas—Rotating, Radio Telescopes, Radar, Tropospheric and Ionospheric Scatter.

BLAW-KNOX

BLAW-KNOX COMPANY
Blaw-Knox Equipment Division
Pittsburgh 38, Pennsylvania



Broadband ferrite isolators for countermeasures systems



MICROLINE NUMBER	D44L2	D44S2	D44C2	D44X2
Frequency:	1-2 kmc	2-4 kmc	4-7 kmc	7-11 kmc
Forward Loss (max.):	1.0 db	1.0 db	0.5 db	0.6 db
Isolation (min.):	10 db	10 db	10 db	10 db
Trans. Line:	RG-44/U ⅞ Coax.	RG-44/U ⅞ Coax.	Double Ridge Wave Guide	Special X-Band Wave Guide

Lightweight units handle high power levels to 400 watts cw

These Sperry isolators are the first nonreciprocal ferrite components designed in coaxial line. They are especially applicable in extremely broadband radars and test equipment as well as advanced countermeasures systems—wherever isolation is required over an octave bandwidth.

Simple in construction and light in weight, these Sperry Microline* isolators have no large waveguide nor heavy magnets. They maintain far superior electrical characteristics over a much broader bandwidth than other isolators. Meeting both Mil.E.-5400A and Mil.E.-5272A specs, they operate properly within an ambient temperature range from –55°C to 100°C.

*TM Reg. U. S. Pat. Off.

SPERRY MICROWAVE ELECTRONICS COMPANY
CLEARWATER, FLORIDA
Division of Sperry Rand Corporation

ADDRESS ALL INQUIRIES *to Clearwater, Florida, or Sperry Gyroscope offices in New York, Cleveland, New Orleans, Los Angeles, San Francisco, Seattle.*

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now, most flexible line of PNP Germanium Power Transistors

40 Watts*

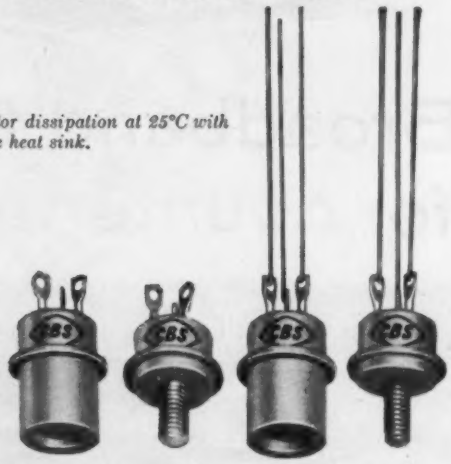
30 Watts*

20 Watts*

*Collector dissipation at 25°C with infinite heat sink.

3 POWER GROUPS

5 PACKAGES



MORE THAN 100 TYPES

40-WATT GROUP
Types Available

Current Gain‡	LT-5096	LT-5105	LT-5114	LT-5123	Diamond
160	LT-5095	LT-5104	LT-5113	LT-5122	Male
	LT-5094	LT-5103	LT-5112	LT-5121	Female
	LT-5093	LT-5102	LT-5111	LT-5120	Diamond
80	LT-5092	LT-5101	LT-5110	LT-5119	Male
	LT-5091	LT-5100	LT-5109	LT-5118	Female
	LT-5090	LT-5099	LT-5108	LT-5117	Diamond
40	LT-5089	LT-5098	LT-5107	LT-5116	Male
	LT-5088	LT-5097	LT-5106	LT-5115	Female
	30V	60V	80V	100V	Packages#

Minimum Breakdown Voltage†

30-WATT GROUP
Types Available

Current Gain‡	LT-5060	LT-5069	LT-5078	LT-5087	Diamond
100	LT-5059	LT-5068	LT-5077	LT-5086	Male
	LT-5058	LT-5067	LT-5076	LT-5085	Female
	LT-5057	LT-5066	LT-5075	LT-5084	Diamond
60	LT-5056	LT-5065	LT-5074	LT-5083	Male
	LT-5055	LT-5064	LT-5073	LT-5082	Female
	LT-5054	LT-5063	LT-5072	LT-5081	Diamond
30	LT-5053	LT-5062	LT-5071	LT-5080	Male
	LT-5052	LT-5061	LT-5070	LT-5079	Female
	30V	60V	80V	100V	Packages#

Minimum Breakdown Voltage†

20-WATT GROUP
Types Available

Current Gain‡	LT-5028	LT-5034	LT-5042	LT-5051	Diamond
60	LT-5027	LT-5033	LT-5041	LT-5050	Male
	LT-5026	LT-5032	LT-5040	LT-5049	Female
	LT-5025	LT-5031	LT-5039	LT-5048	Diamond
40	LT-5024	LT-5030	LT-5038	LT-5047	Male
	LT-5023	LT-5029	LT-5037	LT-5046	Female
	LT-5022	2N157	2N157A	LT-5045	Diamond
20	LT-5021	LT-55	LT-5036	LT-5044	Male
	2N156	2N158	LT-5035	LT-5043	Female
	30V	60V	100V	**120V**	Packages#

Minimum Breakdown Voltage†

‡Minimum large-signal current gain: 40-watt group at 1.0 A, 30-watt group at 0.75 A, 20-watt group at 0.50 A.

†Minimum breakdown voltage, collector to base with emitter open.

#Five packages: diamond, female industrial with solder lugs or flying leads, and male industrial with solder lugs or flying leads.

Reliable products through Advanced-Engineering

CBS semiconductors

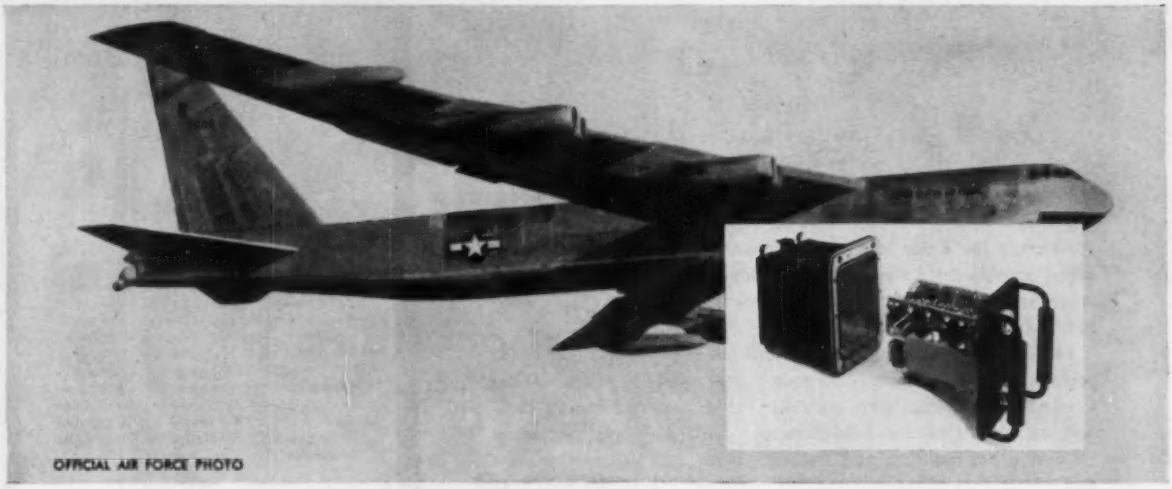
CBS-HYTRON, Semiconductor Operations, Lowell, Mass.
A Division of Columbia Broadcasting System, Inc.
Sales Offices: *Newark, N. J.; Melrose Park, Ill.; Los Angeles, Calif.*

Whatever your needs in PNP germanium power transistors, CBS-Hytron can supply them: In a choice of three sizes of collector dissipations . . . 20, 30 or 40 watts. In a choice of five packages . . . diamond, female industrial with solder lugs or flying leads, and male industrial with solder lugs or flying leads. And in 36 choices of collector-to-base voltages and large-signal current gains.

See tables for types available. Write today for Bulletin E-288 giving complete data on EIA, military and special types in the widest range of current gains, collector voltages and currents available. Let the unsurpassed flexibility and width of this CBS-Hytron line help solve your individual power transistor problems.

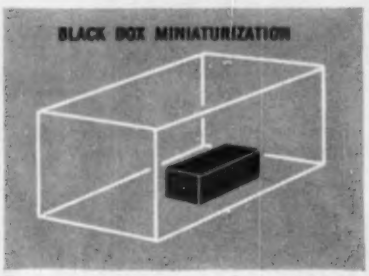
LIQUIDS-IN-ELECTRONICS NEWS... *FROM MONSANTO*

IBM cools current deflection amplifier with Coolanol 45

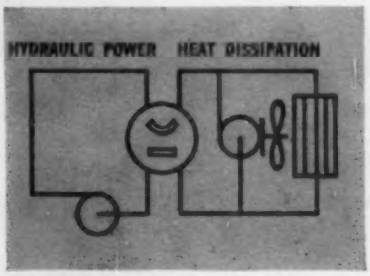


OFFICIAL AIR FORCE PHOTO

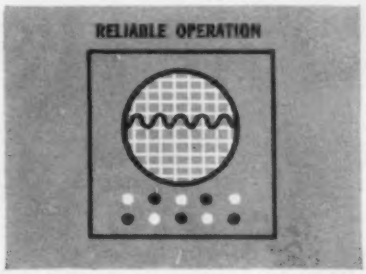
Coolanol 45 dissipates heat from the 360-watt Current Deflection Amplifier produced by IBM Military Products Division for the AN/ASB-4 bombing/navigational system—operational in the B-52 bomber.



For compact design . . . Coolanol 45 dissipates the increased heat created when you must pack more power into less space. Liquid-cooling allows miniaturization of components that must be lightweight, yet powerful enough for today's advanced system designs. It lends itself well to package systems of individual units which can be removed, serviced and replaced easily.



For design simplicity . . . call on the ability of Coolanol 45 to function as a coolant-dielectric *or* as a hydraulic fluid. Coolanol 45 pumps and cools efficiently from -65° to 400° F.—performs well over an environmental temperature range even wider. You can eliminate the variables of multiple fluids or multiphase fluid systems by standardizing on versatile Coolanol 45.



For reliable performance . . . Coolanol 45 provides reliable temperature control to assure accuracy of components such as fire control and countermeasures units. Quality control specifications include passage through an 0.8 micron filter, assuring fluid purity for reliable operation in the close tolerances of your servo mechanisms.

Coolanol 45: Monsanto T. M. (Formerly OS-45)

WHEN YOU NEED A SYNTHETIC FLUID, COME TO MONSANTO

—creator of fluids for the future

Consult Monsanto on the advantages of liquid-cooling for your systems before you select your cooling method. Monsanto technical specialists are ready to help with the fluid aspects of your system design.

Monsanto

Monsanto Chemical Company, Organic Chemicals Division
Dept. AV-5, St. Louis 24, Missouri

Please send more information: ☐ New Coolanol 45 Technical Bulletin
☐ Facts Folder on 20 Monsanto Fluids

Name.....

Company.....

Address.....

City.....*Zone*.....*State*.....

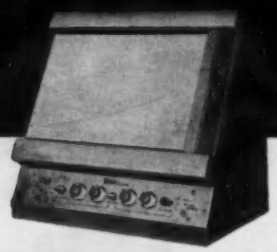
Diode Manufacturer uses Electro Instruments X-Y Recorders to plot Zener diode characteristics

INCLUDES PLOT WITH EACH DIODE

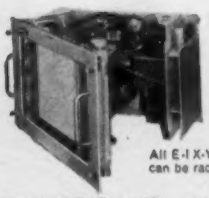
International Rectifier Corporation, manufacturers of Zener diodes, plots the reverse breakdown characteristics of each diode. These plots accompany the diode to the customer and provide an immediately useful graphic description of the individual unit's transfer characteristics. As shown below, the plots are made with an Electro Instruments Model 100 X-Y Recorder.

These proven recorders fulfill the most demanding operational and performance requirements. They possess such advanced design features as transformer-isolated servo-controlled cable drives to eliminate backlash, an internal vacuum hold-down and carriage slewing mechanism for easy paper insertion, and a positive paper indexing provision for measurement repeatability. Operating controls are kept to a minimum and are logically grouped for maximum operator convenience.

the complete line of X-Y Recorders and Data Reduction Accessories



The Model 200 (Computer Output), the Model 215 (Potentiometric Input), Model 225 (General Purpose Plotter) are larger (11" x 17") machines. The basic precision recording capability of these machines is readily expanded to cover more complex input/output data reduction tasks. For this purpose E-I offers a series of auxiliary equipments—Integral Curve Follower, Model 275 Medium Speed Digital to Analog Converter, the Model 250-A Symbol Generator and the Model 260 Time Base Generator.



All E-I X-Y Recorders can be rack mounted

Model 100 Specifications

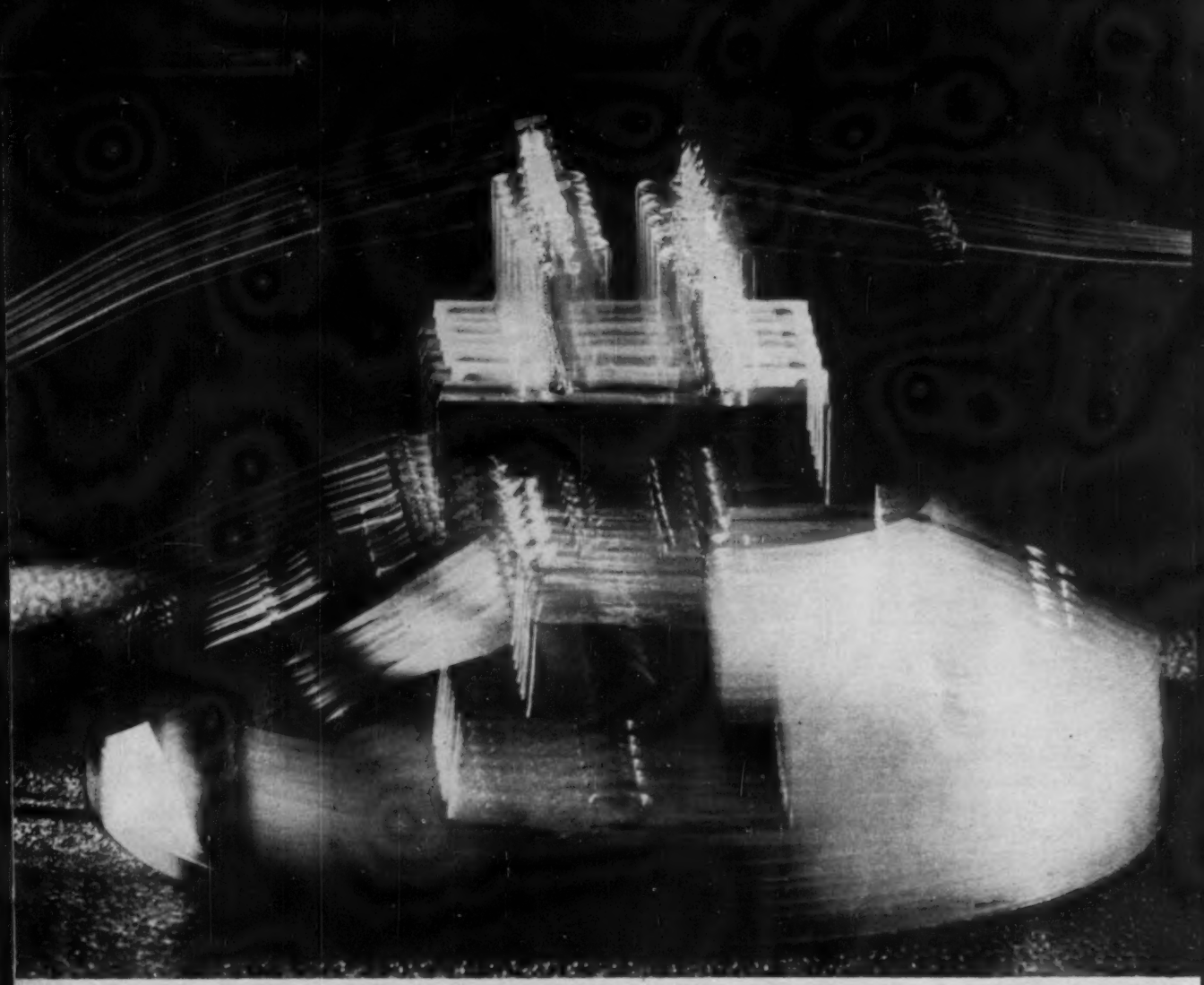
Axes: Independent X and Y isolated axes.
Accuracy: ±0.2% full scale.
Scales: 16 ranges, both axes, from 0.5 mv/inch to 50 volts/inch, mv/inch: 0.5, 1, 2.5, 10, 25, 50, 100, 250 and 500; volts/inch: 1, 2.5, 5, 10, 25 and 50.
Input Resistance: 0.5 mv/inch, essentially infinite at balance with low resistance source: 1.0 mv thru 500 mv/inch, 200 kilohm/volt; 1.0 volt thru 50 volts/inch, 2 megohms.
Zero: Full scale zero control with one full-scale length zero offset provided by 10-turn pots.
Reference: Internal mercury battery.
Paper Size: 8-1/2" x 11".
Slewing Speed: Pen 13" sec.; carriage 19" sec.
Power Input: 115v ±10v, 60 cps., 60 watts standby; 125 watts operating.
Dimensions: 10" (max.) high x 12-3/8" wide x 18" deep.

For complete specifications, send for new 4-page brochure

ELECTRO INSTRUMENTS INC.
3540 Aero Court • San Diego 11, California

CIRCLE 22 READERS SERVICE CARD

CIRCLE 23 READERS SERVICE CARD →



Two Type 7191's receive special "D.C. hold-off" vibration test. *All* Tung-Sol/Chatham miniature hydrogen thyratrons — 7190, 7191, 7192 — must "hold off" while subject to 15G vibration, swept from 50 to 2,000 cps in 4 minutes. Tubes also are shocked at 48° hammer angle in Navy high-impact flyweight shock machine, equal to 720G/1 millisecond shock.

Tung-Sol/Chatham miniature hydrogen thyratrons supply test-proved ruggedness for missile use!

Extensive in-factory tests assure designers Tung-Sol/Chatham miniature hydrogen thyratrons — 7190, 7191, 7192 — can withstand the severe shock and vibration met in missile flight. Performance of these tubes in several operational missiles gives in-use proof of their ruggedness.

In radar modulators and tracking beacons, these compact tough tubes supply 10 KW, replace bulkier types. Broad range of pulse repetition rates widens design choice . . . zero bias simplifies circuitry and triggering requirements. Tubes hold off high voltage, pass high peak current with low tube voltage drop. Three types available: 7190 — pin base, 7191 — top anode connector, 7192 — flexible leads.

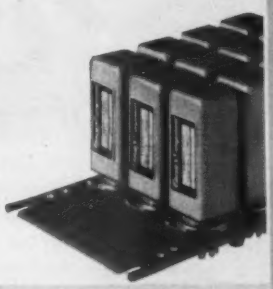
Tung-Sol, only producer of miniature hydrogen thyratrons for missiles, can supply you immediately. For complete data on these types . . . on special-purpose tubes of all types, phone or write. Tung-Sol Electric Inc., Newark 4, New Jersey. Commercial Engineering Offices: Bloomfield and Livingston, New Jersey; Culver City, California; Melrose Park, Illinois.

TUNG-SOL®

EPSCO'S NEW

transistor digital circuits

available now!



- Lowest Cost
- Save Time
- Save Space
- Color Coded
- Shock-Resistant
- Fully-Encapsulated
- Low-Power Requirements
- Proven Dependability
- Complete Compatibility
- Easily Accessible Test Points
- Efficiently Arranged Pin Connections
- 250 KC Operation
- −55°C to +75°C Temperature Range

Standard packages can be modified to provide you with custom circuitry at no extra packaging cost.

Here are important new tools to eliminate your logic circuit design problems. Providing significant cost advantages, Epsco's Transistor Digital Circuits save you valuable engineering design time, cut your costs and space requirements and give you *dependable, reliable* operation.

Type A Circuit Packaging (two-thirds actual size)

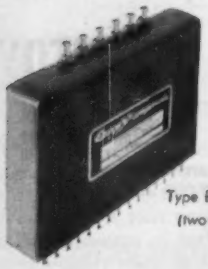
AVAILABLE CIRCUITS

Flip Flops and Counters
Diode AND Gates
Diode OR Gates
Nor Gates — An Epsco Exclusive
Parallel Gates
Cascade Gates
Inverter Amplifiers
Non-Inverting Amplifiers
Emitter Followers
Power Driver
One Shot Delay
Pulse Shaper
Level Converter
Neon Indicator
Incandescent Indicator
Blocking Oscillator
Level Shaper
6, 12, 18 volt Power Supplies
Clock Pulse Generator (0-250C)

Coming soon: complete 1 mc logic circuit family ... and we're adding others all the time.

SPECIFICATIONS

Dimensions	
Type A	2"x.9" square
Type B	2.5"x0.65x2"
Frequency Range	0–250KC
Switching Times	
Diode Logic	0.7 μsec max
Transistor Logic	1.5 μsec max
Signal Voltage Levels	0 and −6 volts
DC Supply Voltages	±18 volts, ±6 volts
Temperature Range	−55°C to +75°C



Type B Circuit Packaging (two-thirds actual size)

Write for technical bulletins.
Epsco Components, Dept. R88,
108 Cummington Street, Boston 15, Mass.

Epsco COMPONENTS

CIRCLE 24 READERS SERVICE CARD

CIRCLE 25 READERS SERVICE CARD →

BUILD YOUR PRODUCT BETTER ...WITH JOHNSON COMPONENTS!

Time after time engineers specify Johnson components

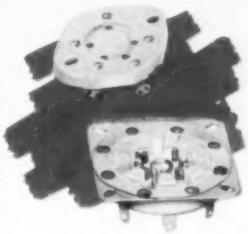
Whatever the choice... from the smallest nylon connector to the largest variable capacitor... time and again design and development engineers specify Johnson components. Outstanding in reliability, Johnson components are backed by sound and imaginative engineering. Next time you're looking for one of the following components—check Johnson first!

- VARIABLE CAPACITORS
- INSULATORS • PILOT LIGHTS
- PLUGS AND JACKS
- INDUCTORS • TUBE SOCKETS
- KNOBS AND DIALS

connectors

Designed to meet severe electrical and mechanical requirements, Johnson manufactures a complete line of nylon connectors as well as a standard group of plugs and jacks. Nylon components include: insulated solderless tip and banana plugs; tip and banana jacks; tip jack and sleeve assemblies; metal-clad tip jacks; binding posts. Tough, low-loss nylon won't chip or crack even when subjected to extreme temperature changes or abnormal mechanical stress. Designed for fast, easy mounting—available in 13 bright colors for coded applications.

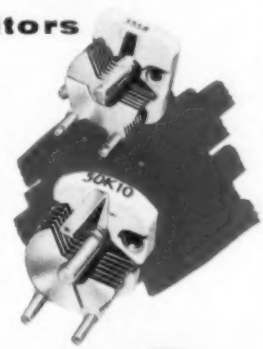
tube sockets



Pick the tube socket that meets your specifications from Johnson's 3 basic grades for every socket type! Check Johnson's standardization program . . . you'll find that selection is simplified, delivery cycles are shorter—and many times you'll get superior quality sockets at lower cost due to the elimination of special set-up and tooling charges. This unique tube socket standardization program provides you with complete specifications for standard, industrial and military socket requirements. Write for your free copy of Tube Socket Standardization Booklet No. 536, today!

variable capacitors

Available in a wide range of capacities and voltage ratings, Johnson Variable Capacitors are widely used for commercial and military applications. Types range in size from the diminutive "M" series to large Type "C" Single and Dual capacitors measuring up to 17 31/32" long. This comprehensive line offers types with construction features such as: soldered plates; DC-200 impregnated steatite end frames; types with stator support rods soldered directly to ceramic end frames; units with high capacity per cubic inch and low capacity to chassis; and types with special platings and spacings in production quantities.



pilot lights

Save valuable specification time by selecting your panel indicators from Johnson's "preferred" line. Available types include: faceted jewel or wide angle lucite lens models; enclosed or open body styles; bayonet, candelabra, or miniature screw types; and a wide variety of mounting brackets and assemblies. Jewels are available in clear, red, green, amber, blue, or opal. Specials, including types to meet military specifications are also available in production quantities. All Johnson pilot lights are described in detail in Pilot Light Catalog 750—send for your free copy today!

Free Catalog

For detailed specifications on the complete line of Johnson electronic components—write for your free copy of our newest component catalog, today!

E. F. Johnson Company

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Around the World in 80 Years

. . . plastics parts molded by Consolidated, that is. In every part of the globe — from Scranton, Pennsylvania to Sidney, Australia — people are using and enjoying products made more dependable by components from Consolidated. Now, with two plants working for you in Scranton, Pennsylvania, and one in Binghamton, New York, we are better prepared than at any other time in our 80 year history to take care of your requirements.

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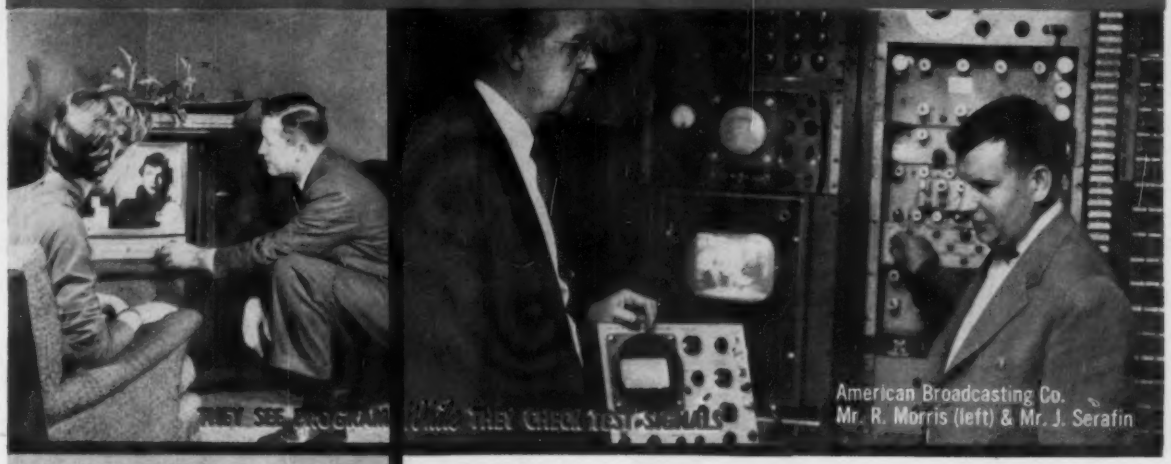
IF YOU are interested in learning more about injection and compression molding by Consolidated, send for our new, fully illustrated company brochure. Write to: Consolidated, 339 Cherry Street, Scranton 2, Pennsylvania.

New – SEND TEST SIGNALS DURING PROGRAMMING



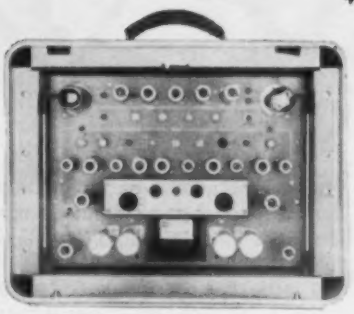
TELECHROME MFG. CORP.

VERTICAL BLANKING INTERVAL TEST SIGNAL KEYER

The Telechrome Model 1008-A Vertical Blanking Interval Keyer is a self-contained portable unit that makes possible transmission of television test and control signals between frames of a TV picture. Any test signal (multiburst, stairstep, color bar, etc.) may be added to the composite program signals. The keyer will operate anywhere in the TV system and operates from composite video, sync, or H & V drive. The test signals are always present for checking transmission conditions without impairing picture quality. The home viewer is not aware of their presence.

These continuous reference signals may be used in connection with various Telechrome devices for automatic correction of video level, frequency response, envelope delay, differential gain and differential phase.

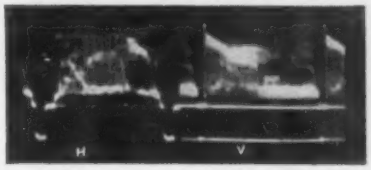
MODEL 1008-A



VERTICAL BLANKING INTERVAL TEST SIGNAL KEYER

Portable or standard rack mounting. Self-contained power supply.

Test signal is thin line between frames. All test signals can be transmitted during vertical blanking portion of program.



Video picture with multiburst test signal inserted, as seen on ordinary wave monitor.

IMPORTANT:

Checking after programming is costly and at best highly inefficient since conditions constantly vary. The Telechrome Vertical Interval Keyer minimizes post-program checking and overtime expenses. It provides instant indication of deteriorating video facilities so that corrective measures can be undertaken immediately—manually or automatically during programming.

Now in use by CBS, NBC, ABC, BBC ITA (Brit.)

1003-C VIDEO TRANSMISSION TEST SIGNAL GENERATOR

Completely self-contained, portable. Produces multi-frequency burst, stairstep, modulated stairstep, white window, composite synch. Variable duty cycle. Regulated power supply. 12¼" standard rack mounting or in carrying case. Integrates with above model 1008-A Test Signal Keyer.

Write for Specifications & Details

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The Nation's Leading Supplier of Color TV Equipment

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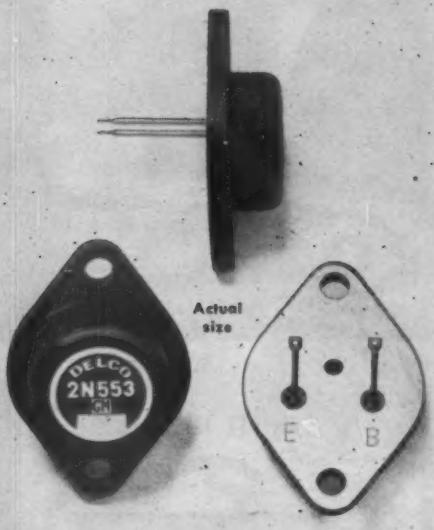


ANNOUNCING...

the newest addition to the Delco family of PNP germanium transistors! It's ideally suited for high-speed switching circuits and should find wide use in regulated power supplies, square wave oscillators, servo amplifiers, and core-driver circuits of high-speed computers. It's the 2N553!

NEW HIGH-FREQUENCY POWER TRANSISTOR BY DELCO

No other transistor offers so desirable a combination of characteristics for applications requiring reliability and consistency of parameters.

TYPICAL CHARACTERISTICS T = 25°C unless otherwise specified

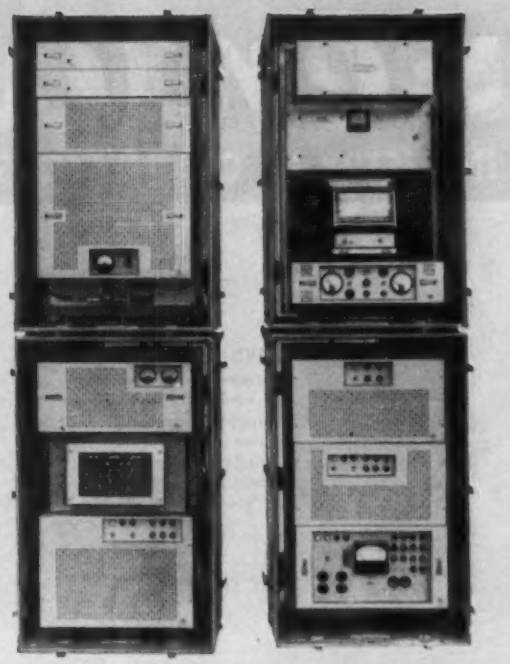
Collector diode voltage V_{CB} (V_{EB} = −1.5 volts)	80 volts maximum
Emitter diode voltage V_{EB} (V_{CB} = −1.5 volts)	40 volts maximum
Collector current	4 amps. maximum
Base Current	1 amp. maximum
Maximum junction temperature	95°C
Minimum junction temperature	−65°C
Collector diode current I_{CO} (V_{CB} = 2 volts)	12 μa
Collector diode current I_{CO} (V_{CB} = −60 volts)	0.5 ma
Collector diode current I_{CO} (V_{CB} = −30 volts, 75°C)	0.5 ma
Current gain (V_{CE} = −2 volts, I_C = 0.5 amp.)	55
Current gain (V_{CE} = 2 volts, I_C = 2 amps.)	25
Saturation voltage V_{EC} (I_B = 220 ma, I_C = 3 amps.)	0.3
Common emitter current amplification cutoff frequency (I_C = 2 amps. V_{EC} = 12 volts)	25 kc
Thermal resistance (junction to mounting base)	1° C/watt

BRANCH OFFICES

Newark, New Jersey
1180 Raymond Boulevard
Tel: Mitchell 2-6165

Santa Monica, California
726 Santa Monica Boulevard
Tel: Exbrook 3-1465

DELCO RADIO Division of General Motors
Kokomo, Indiana



Transmitter terminal

Propagation testing made portable

With the continual increase in tropo scatter systems—most of which have been developed and manufactured by REL—has come heightened need for truly portable propagation test equipment to survey proposed scatter transmission paths.

The solution is available in REL's new path test set. Here, for the first time, is packaged transmitting and recording receiving apparatus which is not only small and light, but supremely rugged as well.

Packaged with each set are replacements for all necessary components, many in preassembled form. Parts supply depots are unnecessary, and delays thereby eliminated.

Complete details may be obtained upon request.

SYSTEM

Frequency range: 875 mc to 950 mc*
Power output: 20 or 120 w
Noise threshold: —167 dbw or 0.032 μv in 50 ohms
Recording range: 60 db, 40 db, or 20 db—log-linear
Radio gain: 180 or 188 db
Frequency stability: ±1 pp 10^8 short term
±1 pp 10^7 long term
Primary power: 120 volts ±10%, 50-63 cps
Ambient operating temperature: —18° to +54°C
Non-operating temperature: —65° to +85°C

TRANSMITTER

Modulation: None; cw operation. Provision is made to key power output for identification.
Power output recording: 6-inch strip recorder available

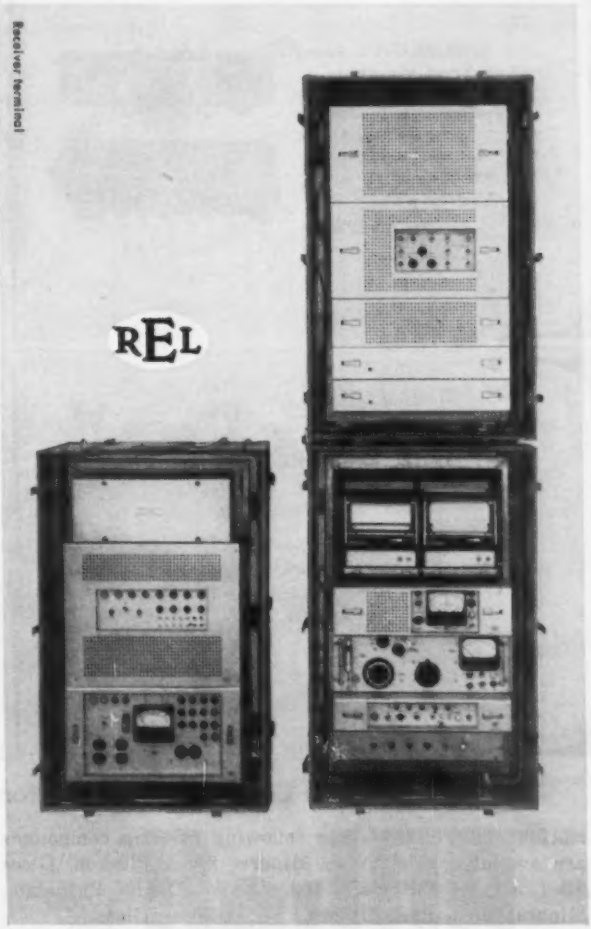
RECEIVER

Bandwidth: 1 kc
Noise figure: 7 db
Recorder: 6-inch strip recorder
Calibration: Signal level and recording linearity by internal means.

MECHANICAL

All cases are 26 1/16" wide by 20 5/16" deep by 40 9/16" high
Cases may be stacked two high during operation.
The weight varies from 200 lbs to 350 lbs depending on case contents.

**Also available in ranges of 435-475 mc & 1750-1900 mc*



Receiver terminal

Radio Engineering Laboratories·Inc

A subsidiary of Dynamics Corporation of America

29-01 Borden Ave · Long Island City 1, N Y

STillwell 6-2100 · Teletype: NY 4-2816

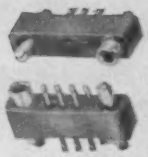
Canadian representative: AHEARN & SOPER CO · 384 BANK ST · OTTAWA

Continental

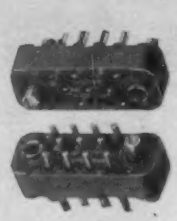
LEADING THE ELECTRONIC INDUSTRY IN CONNECTORS FOR

STANDARD SERIES

MICRO-MINIATURE — Ultra miniaturization without performance loss. Ruggedized to withstand shock and vibration extremes. Available with 5, 7, 9, 11, 14, 20, 26, 29, 34 and 44 contacts for #22 AWG wire. 3 amps, 1800V RMS.



SERIES MM-22
ACTUAL SIZE

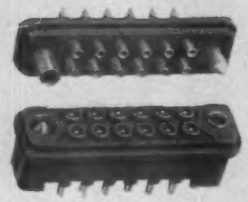


SERIES SM 20
ACTUAL SIZE

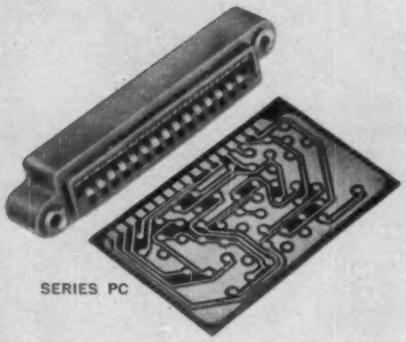
SUB-MINIATURE — A rugged component, ideal where space and weight are at a premium. Available with 5, 7, 11, 14, 20, 26, 34, 42 and 50 contacts for #20 AWG wire. 5 amps, 1900V RMS.

QUICK RELEASE* — Spring loaded pin contacts eliminate pulling and prying. Prevent damage to contacts. Up to 34 contacts for #16 or #12 AWG wire. 10 amps, 4500V.

*Pat. No. 2,736,870



SERIES E-Z



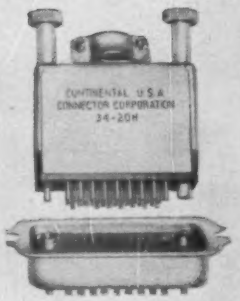
SERIES PC

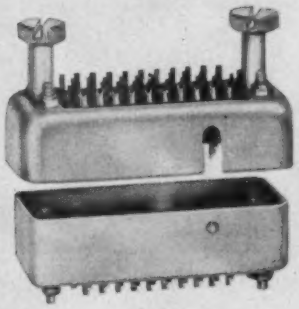
PRINTED CIRCUIT — Provide a direct connection of wiring to printed circuitry. For 1/16", 3/32", and 1/8" boards. Carry up to 58 new "BELLOWS ACTION," bifurcated contacts for utmost reliability. Various terminations including wire wrap, solder lug and taper pin are available.

SPECIAL ACCESSORIES

POLARIZING SCREW-LOCKS* — Prevent accidental disconnection due to vibration. Available in Micro-Miniature, Sub-Miniature and Miniature connectors.

*Pat. No. 2,746,022





PROTECTIVE ALUMINUM SHELLS — Complete protection against physical damage. For Miniature and Sub-Miniature series. With or without stainless steel polarizing screw-locks.

You can rely on Continental Connectors to solve any precision connector problem.

MOLDING COMPOUNDS — The following molding compounds are available: Melamine, Mineral filled, Plaskon, Glass filled, Diallyl Phthalate, Orlon filled, Diallyl Phthalate, Mineral filled, Phenolic Mica and Silicone Glass.

SPECIAL APPLICATION PROBLEMS — You are invited to present your special application problems to our engineers for intensive study, consultation and prototypes. Write for technical literature on any of the connectors illustrated above.

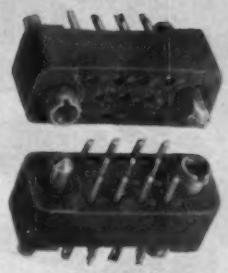
NEW CLOSED RING ENTRY CONTACT — Extremely high reliability. Solid ring limits contact expansion to maximum tolerance of pin diameter. Cannot be forced out of shape. Maintains low mv. drop under constant and uniform insertion pressure.

CIRCLE 30 READERS SERVICE CARD

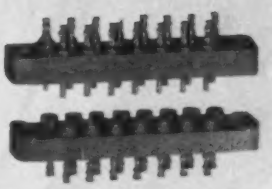
Connectors

GUIDED MISSILES, COMMUNICATIONS, AND COMPUTERS

MINIATURE – A compact, lightweight connector available with a wide range of contacts from 4 to 104. Types available with coaxial contacts – 50-ohm or 70-ohm matched impedance.



SERIES 20
ACTUAL SIZE

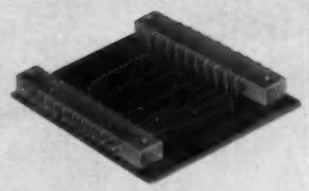


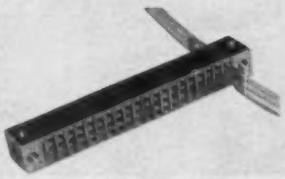
SERIES 14
½ ACTUAL SIZE

POWER – Many types available. Heavy duty Series 14 shown, features telescoping contact barriers for unusually long creepage paths; 7, 9, 10, 15 and 18 contacts; #14 or #16 AWG wire; 10 amps, 4500V.

STANDARD SERIES

RIGHT ANGLE PRINTED CIRCUIT – Pin and socket connectors for dip soldering to printed circuit boards or cable. Available in various contact sizes and terminations.

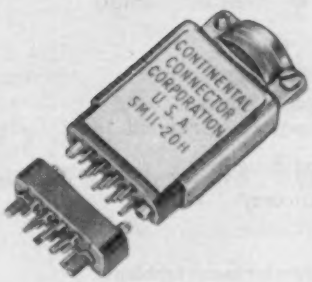


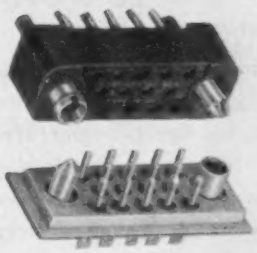


SERIES 145-48
⅓ ACTUAL SIZE

TERMINAL BLOCKS – Rugged, molded, machine tapered pin terminal blocks. Available in any combination of shorting or non-shorting terminals. Single, dual or triple row.

ALUMINUM HOODS – Relieve cable strain, act as convenient grip for disconnecting. Available for all connectors, except printed circuit.





HERMETIC SEAL – Designed especially for high altitude and similar applications. Contacts are individually sealed and fused in glass. Available with Miniature and Sub-Miniature series.

SPECIAL ACCESSORIES

FREE SLIDE RULE CONNECTOR GUIDE – A slide rule guide that shows standard Continental Connectors with electrical and mechanical ratings as well as a Body Molding Comparator for standard molding compounds will be mailed to you with our compliments if you write on your company letterhead. There is no obligation, of course.

Manufactured by Continental Connector Corporation, America's fastest growing line of precision connectors.

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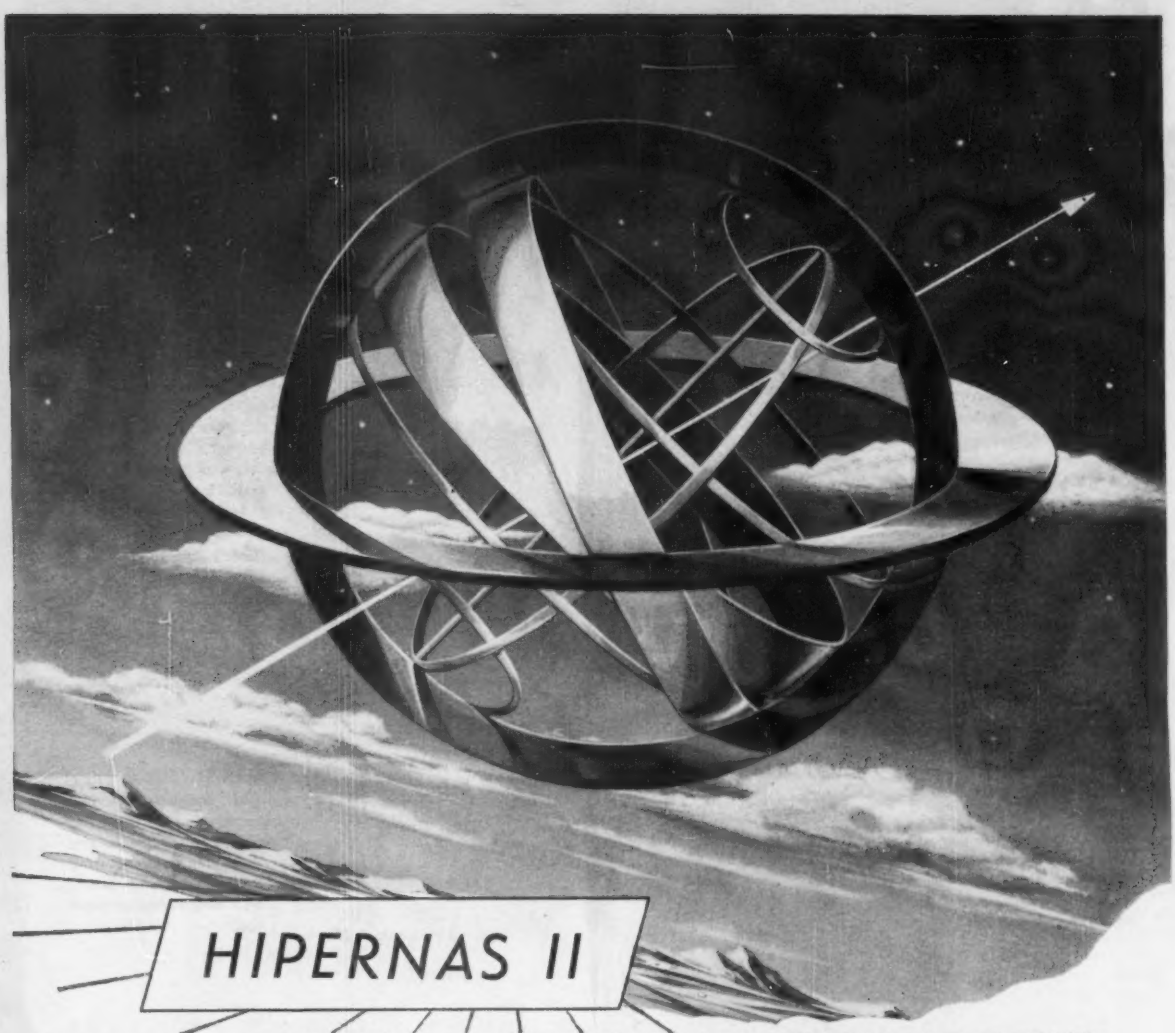
CIRCLE 31 READERS SERVICE CARD



HIPERNAS II

A new concept in advanced *INERTIAL NAVIGATION SYSTEMS*

Bell has outstanding opportunities for experienced engineers and scientists in the following areas:

- Inertial navigation system analysis and design
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- Inertial test equipment development and design
- Transistorizing of analogue and pulse circuitry
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Assignments embrace a high level of design and development problems. Learn about the personal opportunities and unexcelled benefits now available to you on this challenging program. Send resume of your qualifications to: Supervisor of Engineering Employment, Dept. H-42, BELL AIRCRAFT CORPORATION, P. O. Box One, Buffalo 5, New York.

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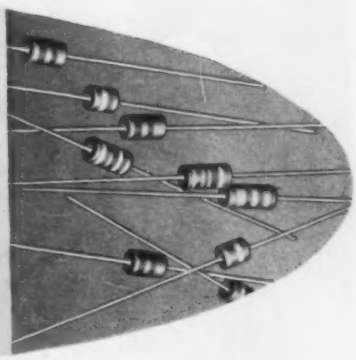
WHEN A LITTLE CAPACITANCE GOES A L-O-N-G WAY...

STACKPOLE

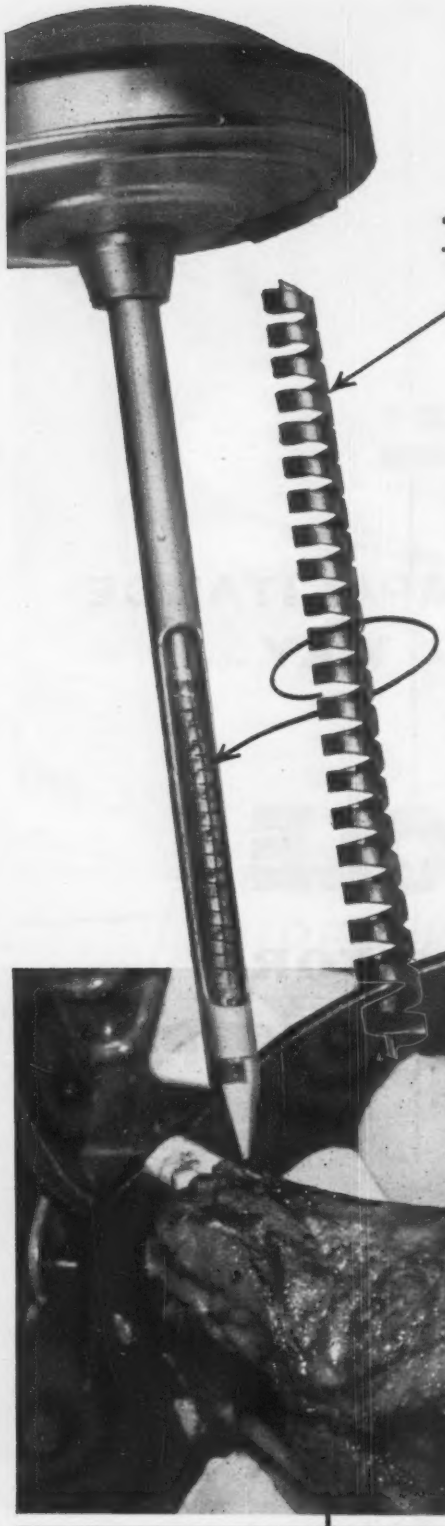
FIXED COMPOSITION CAPACITORS SET THE QUALITY STANDARDS!

Convenient, circuit coupling and bypassing in the simplest, most inexpensive capacitor design ever produced. 46 EIA "preferred" values—0.10 to 10.0 $\mu\mu$f. 5%, 10% or 20% tolerances.



Electronic Components Division
STACKPOLE CARBON COMPANY
ST. MARY'S, PA.

Colclite 70+® fixed composition resistors • Snap and Slide Switches • Ceramag® ferromagnetic cores • Variable composition resistors • Ceramagnet® ceramic magnets • Fixed composition capacitors • Iron cores • Brushes for all rotating electrical equipment • Electrical contacts • Hundreds of related carbon, graphite and metal powder products.



Dependable Consistency of

GENERAL PLATE

TRUFLEX THERMOSTAT METALS

Enables COOPER to Give

Liberal Warranty

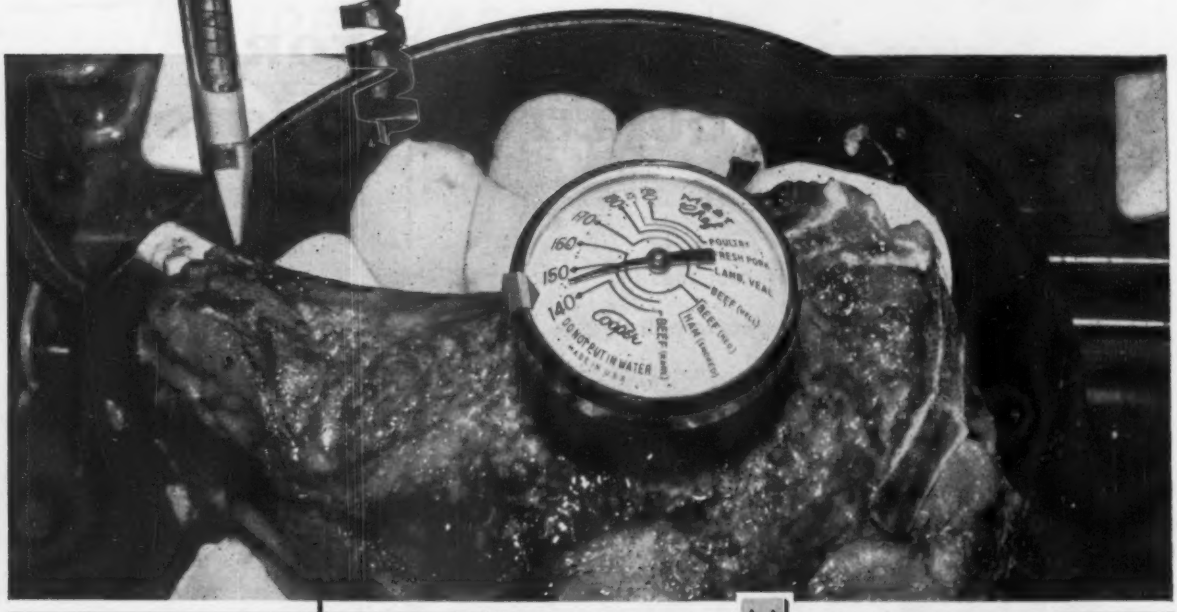
The new MEAT CHEF Thermometer by COOPER, featuring the exclusive VISI-DOME DIAL, helps people cook any meat to perfection with ease.

To insure accurate register of roasting temperature Cooper Thermometer Company specifies and uses General Plate Truflex Thermostat Metals, from which they produce coils as shown in enlarged form at the left. Here's what Cooper President, Horace R. Whittier, has to say about it:

Truflex is unvaryingly uniform in operating characteristics, and this enables us to give the liberal warranty we print on each thermometer box.

General Plate TRUFLEX is available in cut strips or long length coils to meet your needs, or can be furnished in formed elements or completed assemblies to meet the most exacting parts specifications. Either way you get accurate consistent performance with TRUFLEX because every repeat order is an exact duplicate of the original — dependably uniform in activity, temperature range, electrical and corrosion resistance.

To new or regular users of thermostat metal General Plate has much to offer — we'll supply complete technical literature on TRUFLEX — help with parts design — furnish calibrated samples. Our competent Field Engineers will gladly call at your request and show you how temperature change can be put to work in your products — no obligation. Write today.



You can profit by using General Plate Clad Metals.

METALS & CONTROLS CORPORATION

General Plate Division

1308 Forest Street, Attleboro, Mass.

FIELD OFFICES: NEW YORK • CHICAGO • DETROIT • INDIANAPOLIS • MILWAUKEE • PASADENA

...the record tells you more

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DESIGNED SPECIFICALLY FOR YOUR TYPE OF WORK

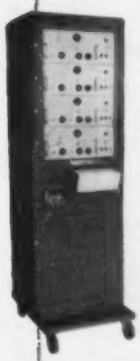
MODEL 276 CHART VIEWER

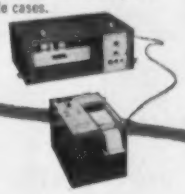
Permits convenient, variable speed editing and study of Sanborn charts and other types up to 16" wide, 200 ft. long. Single control for direction, paper speeds (15" to 100"/min). Transparent cursor slides left or right, adjusts for accurate alignment with coordinates.

1- TO 6-CHANNELS, 12 PLUG-IN PREAMPLIFIERS

150 SERIES

Features of the "150 series" direct writers include: frequency response to 100 cps; linearity 1% overall; inkless recording in true rectangular coordinates by heated stylus on plastic coated Permapaper charts; current feedback driver amplifier and regulated power supply for each channel. Recorder has 9 chart speeds, 0.25 to 100 mm/sec; individual stylus heat controls, time-code marker. Up to 6-channels can be housed in one vertical cabinet. Amplifiers, recorder also available in individual portable cases.





6-, 8-CHANNELS, FLUSH FRONT RECORDER, FREQUENCY RESPONSE TO 120 CPS

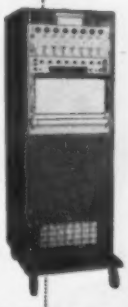
350 SERIES

New "350" series direct writers with compact plug-in preamps in modules of up to 4; individual power supplies; current feedback transistorized power amplifiers; limiter circuit ahead of power amplifiers; velocity feedback galvanometer damping; enclosed galvanometers. Linearity 0.2 div. over entire 50 divisions. Recorder-power amplifier-power supply package has 0.1 volt/div. sensitivity, can be used separately; pushbutton controls for 9 chart speeds 0.25 to 100 mm/sec; individual stylus heat controls; contacts for remote control; inkless rectangular coordinate recording on Permapaper charts.

6-, 8-CHANNELS

850 SERIES

Compact "850" series direct writers use 7" high plug-in preamplifiers in modules of up to eight and "350" flush front recorder package with transistorized power amplifiers, power supply; features velocity feedback galvanometer damping, linearity 0.2 div. over entire 50 divisions; 9 chart speeds from 0.25 to 100 mm/sec controlled by electric pushbuttons; inkless recordings on Permapaper charts. Available preamps include Servo Monitor (demodulator) and DC Coupling. Carrier, Chopper Stabilized and Low Level types are in development.



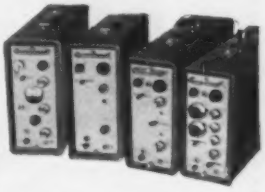
COMPUTER READOUT . . . AUTOMATIC PROGRAMMING

150 SERIES

"150 series" 6-, 8-channel consoles in 46½" high mobile cabinet. Dual-Channel Amplifiers have selectable sensitivity from 0.01 to 10 volts/div.; internal calibration 2 volts ±1% freq. response flat to 20 cps. Optional Programmer sequences system operation in 20 steps, including recorder turn-on, calibration, computer DC level reading, recording for pre-set time, turn-off and reset.

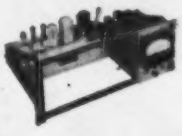
SELF-CONTAINED UNIT PREAMPLIFIERS TO DRIVE 'SCOPES, OPTICAL OSCILLOGRAPHS, TAPE RECORDERS, ETC.

Portable "350" series include Carrier, DC Coupling Servo Monitor (demodulator), True Differential DC types; others in development. Mount in portable "450" cases or in four-unit modules in 19" frame. Use individual power supplies. One "450" case and power supply can serve any "350" Preamp.



PORTABLE INDICATORS FOR STRAIN, ETC.

Model 150-300/700 Wide Band Amplifier and Power Supply accepts "150" series preamplifiers — for use with low power galvanometers, oscilloscopes, panel meter. Freq. range DC to 10,000 cps (but limited by particular preamp range). Panel meter has center zero scale, 25 divisions each side of center.



SALE DATA SUBJECT TO CHANGE WITHOUT NOTICE

For complete data, call your local Sanborn Engineering Representative or write the Industrial Division in Waltham.

SANBORN COMPANY

Industrial Division

175 Wyman Street, Waltham 54, Mass.

"VISIT SANBORN BOOTHS 1454-1455 AT WESCON SHOW"

VICTOR DIGIT-MATIC PRINTERS

Proved by over 16,000,000 printings without repairing, adjusting or cleaning!

The adding machine in the Digit-Matic has been tested with over 16,000,000 continuous printings, with no failure, no service other than periodic oiling. Forty years of experience in producing 1,500,000 adding machines—as well as precision instruments such as the Norden Bombsight—has given Victor Adding Machine Co. outstanding qualifications for producing rugged and reliable digital printers.

CHECK THESE 4 VICTOR ADVANTAGES

Reliability: Examine the rugged construction of a Victor machine. Each part is conservatively designed to provide extended life and reliability. Wearing surfaces heat treated, cyanide hardened to stand up under constant use. All steel parts cadmium plated to prevent rusting.

Immediate Service: Factory-trained servicemen (and parts) are on call in more than 725 cities coast to coast.

Flexibility: At least 500,000 different combinations available, with speeds up to 33 characters per second. With Victor Digit-Matics you have your choice of listers, accumulators, or calculators *plus* an almost infinite number of other variations ranging from electrical noise filters to upside-down printing.

Fast Delivery, Low Price: Because of Victor's continuous high volume of adding machine production, we can ship almost any quantity of Digit-Matics—built specifically to your order—within 30 days. Victor Digit-Matics, from only $425.00, are the value buy in the digital printer field.

IN OPERATION—BOOTH 1210—WESCON SHOW

VICTOR SERIAL ENTRY DIGIT-MATIC PRINTER

10 Digit solenoids. Digits are entered in sequence with most significant digit first. Accepts digits at a rate up to 20 per second. Print cycle: listers 0.27 seconds; accumulators 0.35 seconds. Available in up to 11 column entry capacity.

COIL DATA

Voltage	21-28VDC	42-54VDC	125-160VDC
Resistance, ohms			
Digit solenoid	25.5	75.0	490.
+ or − Print solenoid	25.5	75.0	450.
Minimum on time, seconds	.02	.02	.02
Maximum on time, seconds (continuous printing)	.05	.05	.05

Minimum off time between digits—all serial entry machines—.025 seconds.

COVER REMOVED

VICTOR PARALLEL ENTRY DIGIT-MATIC PRINTER

All digits 1 through 9 of each column equipped with solenoids. Digit and print command solenoids may be simultaneously energized. Print cycle:—listers 0.30 seconds; accumulators 0.35 seconds. Available in up to 10 columns entry capacity.

COIL DATA

Voltage	20-28VDC	35-56VDC	125-160VDC	105-125VAC
Resistance, ohms				
Digit solenoid	17.6	53.0	700.	125.
+ Print solenoid	17.6	89.0	375.	125.
− Print solenoid	17.6	53.0	375.	125.
Minimum on time, seconds	.020	.020	.015	.025
Maximum on time, seconds (continuous printing)	.050	.050	.035	.050

A few popular model variations:—columnar spacing; right side of machine accumulating and left side listing data identification; Non-Add printing; Non-printing adding; MIL-I-17623 Electrical Motor Noise elimination; Induction Motors; Manual Keys over the solenoids; "digit key depressed" switch (serial entry Digit-Matics); tag and label printing; and all kinds of alphabetic and special types.

Write today! Victor's electronics-trained staff will gladly help you solve any digital printing or calculating problem.

Write for technical manual No. A8-71

Electronics Division

VICTOR ADDING MACHINE CO.

3900 N. Rockwell Street, Chicago 18, Ill.

CIRCLE 36 READERS SERVICE CARD

CIRCLE 37 READERS SERVICE CARD→

AF VHF

EIMAC FIRST

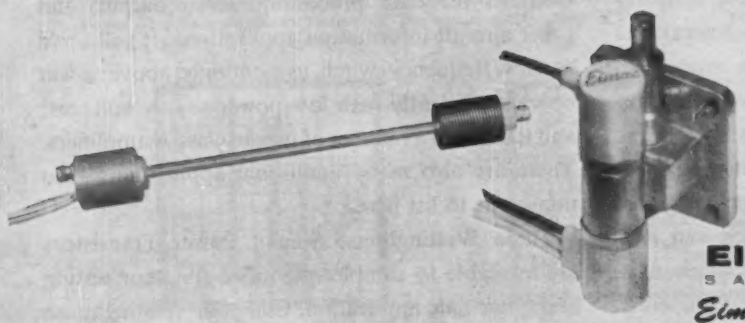
Covering the Spectrum with Reliable Ceramic Tubes

UHF

From audio into super high frequencies, Eimac covers the RF spectrum with modern ceramic tubes. This incomparable ceramic electron tube family—more than one-third of the Eimac line—includes reflex and amplifier klystrons, negative grid tubes, rectifiers, pulse modulators, receiving tubes, and traveling wave tubes. The tubes illustrated are typical of more than 40 Eimac ceramic tube types that are being selected by leading equipment manufacturers for use in all types of applications—from tropo-scatter to industrial heating, from single sideband to pulse.

Visit the Eimac booths, 1230-31 and 1234-35, at WESCON, August 19 to 22, in Los Angeles. Operate the unique demonstrator which hammers impact shocks upon a live Eimac ceramic tube—and prove to yourself the superiority of ceramics in electron tubes.

SHF



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Eimac First with ceramic tubes that can take it

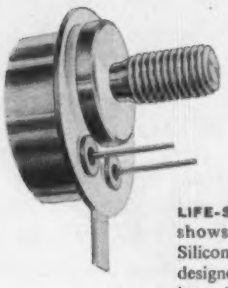
PRODUCTS DESIGNED AND MANUFACTURED BY EIMAC

Negative Grid Tubes
Reflex and Amplifier Klystrons
Ceramic Receiving Tubes
Traveling Wave Tubes
Vacuum Tube Accessories
Vacuum Switches
Vacuum Pumps

Includes the most extensive line of ceramic electron tubes

WESTINGHOUSE TAKES A GIANT STEP

Through major improvements in silicon purification and transistor fabrication, Westinghouse has broken down the previous limitations of Silicon Power Transistors. The result is a new series of Westinghouse Power Transistors which can operate at high efficiencies in the "true power range."



LIFE-SIZE DRAWING shows how Westinghouse Silicon Power Transistor is designed for attachment to heat sink with a screw stud. All leads are in the base.

THESE are the first members of an entirely new family of Westinghouse Silicon Power Transistors, which have the advantages associated with silicon (high voltages and high operating temperature) without the disadvantages (high losses). As you can see from the chart on the right-hand page, these units possess exceptionally low saturation resistance—less than one half ohm. This low saturation resistance which results in low internal dissipation, coupled with high power handling capacity, makes possible silicon transistors which can efficiently handle 1000 or 1500 watts. For example, as a DC switch, handling 1.5 kw (300 volts at 5 amperes) the internal dissipation of the units is about 12.5 watts with a resulting efficiency of better than 99%. Typical reverse leakages are 3 milliamperes.

Like other silicon devices, these transistors can operate in ambient temperatures up to and exceeding 150°C while germanium units are limited to 85°C. Thus, where the higher power rating is not required these units may be used for their high temperature capabilities. It also follows that wherever germanium power units are presently employed, a switch to silicon transistors will result in higher reliability of operation, because of the greater margin of safety with respect to operating temperature.

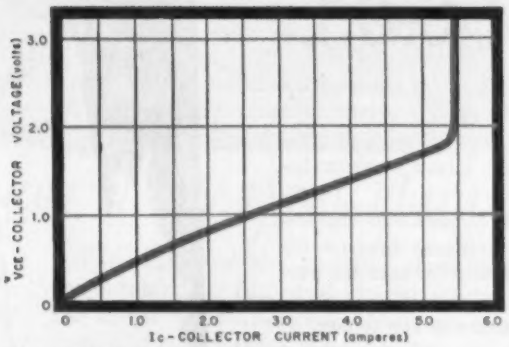
There are a great many circuits for which this new type of silicon power transistor is made to order. It will find use in inverters or converters (AC to AC, AC to DC, DC to AC, DC to DC), to control frequencies for data processing, servo output, and other aircraft information applications. It will serve as a low frequency switch, as mentioned above; it will operate efficiently with low power supply voltages; and it will find a number of uses in class A amplifiers. There are also many additional applications—too numerous to list here.

These Westinghouse Silicon Power Transistors are available in sample quantities for your testing and immediate application. Call your Westinghouse representative or write directly to Westinghouse Electric Corporation, Semiconductor Dept., Youngwood, Pennsylvania.

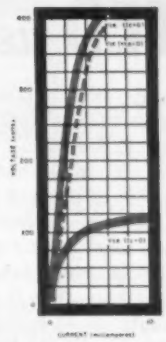
IN SILICON POWER TRANSISTORS

	current rating	V_{CBO}	V_{CE} (V_{EB}=O)	R s
X 107-2	2 amperes	30-300V	30-300V	0.5 ohms Typical
X 107-5	5 amperes	30-300V	30-300V	0.4 ohms Typical

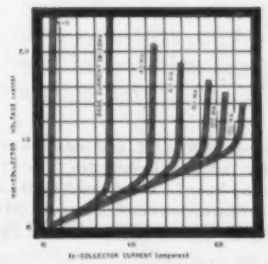
Thermal resistance—Junction to case, 0.7°C/watt typical. Current ratings based on the current at which current gain is equal to or greater than 10. It is possible to switch higher collector currents with some sacrifice in gain.



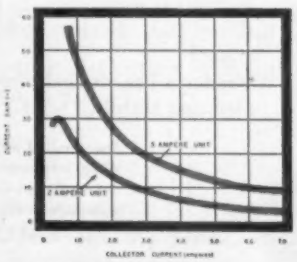
LOW SATURATION RESISTANCE
is exhibited in this graph showing values for a typical Westinghouse Silicon Power Transistor driven to 5 amperes. The values are fractions of those observed in other silicon transistors.



VOLTAGE CHARACTERISTICS
of a 300-volt unit are shown here. High emitter-base voltage may be important in some circuits. In this illustration emitter-base reaches 100 volts.



COMMON EMITTER OUTPUT CHARACTERISTICS
are charted here for the lower current outputs. The characteristics saturate sharply.



DC CURRENT GAINS
are presented as functions of collector-emitter current in the 2 ampere- and 5 ampere-rated units.

YOU CAN BE SURE...IF IT'S

Westinghouse

STOPPED *making our own etchant* STARTED *using* HUNT S.C.E.

"We used to make our own etchant for solder plated circuit boards until we heard of HUNT S.C.E. Solution.

"To mix our own etchant we used to stock large quantities of chromic and sulphuric acid. It took time to make up the solutions which filled the air with noxious fumes and was always dangerous to handle. Besides the time it took to make up the solutions we ended up with variations from batch to batch. And in order to get the solution working right, we had to heat it up to 140° F and over.

"So we did the wise thing... stopped making our own and started to use HUNT S.C.E. which works at room temperature. Now we have no more chemical dangers. We are really saving money — etching time is standardized and we maintain a uniform production rate around the clock."

HUNT S.C.E. (Solder Circuit Etch) is superior to plant mixed etchants because it:

1. Etches rapidly at room temperature.
2. Is a ready, prepared product designed specifically for this one purpose.
3. Has a high capacity for copper.
4. Never attacks the solder plated circuit.
5. Has guaranteed uniformity and is the highest quality because of rigid laboratory control.
6. Gives fast, odorless etching of the copper.
7. Produces boards that pass all corrosion and stability tests.

For detailed information about HUNT S.C.E. and valuable production handling information, write for Technical Bulletin No. 3 — *"The Etching of Solder Plated Circuit Boards by Hunt S.C.E. Solution."* Hunt S.C.E. Solution is available in 125 pound (12 gallon) carboys and 530 pound (55 gallon) drums.

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PHILIP A. HUNT COMPANY

PALISADES PARK, N. J.

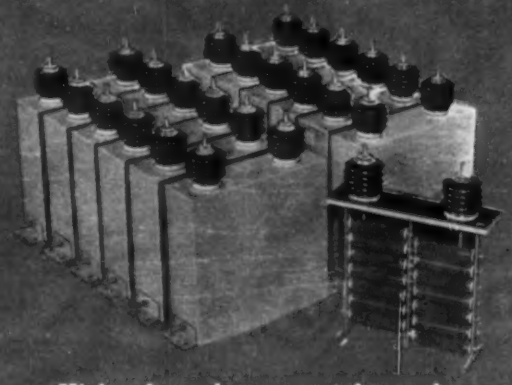
Chicago • Cleveland • Cambridge • Brooklyn • Atlanta • Dallas • Los Angeles • San Francisco

Radio Receptor *hcd** petti-sel *selenium rectifiers*

*high current density

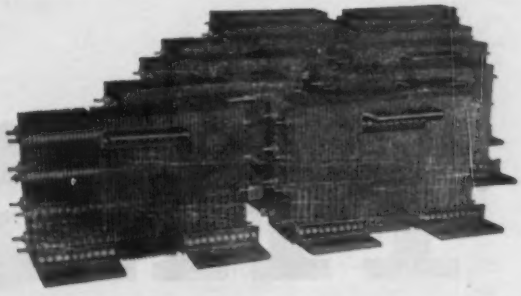
Life expectancy of 100,000 hours

800 ma D.C., 15,000 volts



High voltage, low current for smoke precipitation. 12 containers required.

50,000 amps, 9 volts D.C.



High current, low voltage, fan cooled. For electroplating power supply.

makes them first choice for these applications

The engineers who specified these Radio Receptor rectifiers know the outstanding record of similar stacks in Germany and throughout the world. They also know they can install RRco. Petti-Sel rectifiers once and forget them, confident they'll deliver up to 100,000 hours of trouble-free performance!

Produced by the improved new vacuum process developed by Siemens of West Germany, and now manufactured exclusively in the U. S. by Radio Receptor, Petti-Sel rectifiers are available in an even wider range of current and voltage ratings than indicated above. We'll gladly send you information regarding your rectification problems. For prompt attention, write today to Section E-8R.

Semiconductor Division
RADIO RECEPTOR COMPANY, INC.
Subsidiary of General Instrument Corporation
240 Wythe Avenue, Brooklyn 11, N. Y. EVergreen 8-6000

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GENERAL INSTRUMENT CORPORATION ALSO INCLUDES
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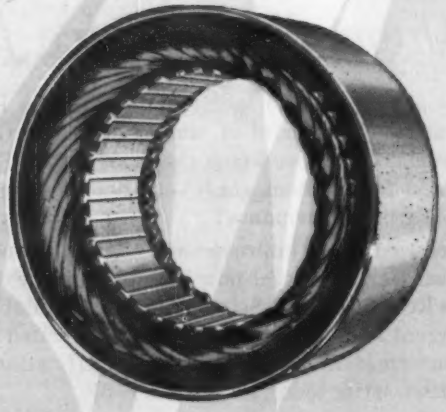
NOW!

A HIGH TEMPERATURE FILM WIRE DEVELOPED BY

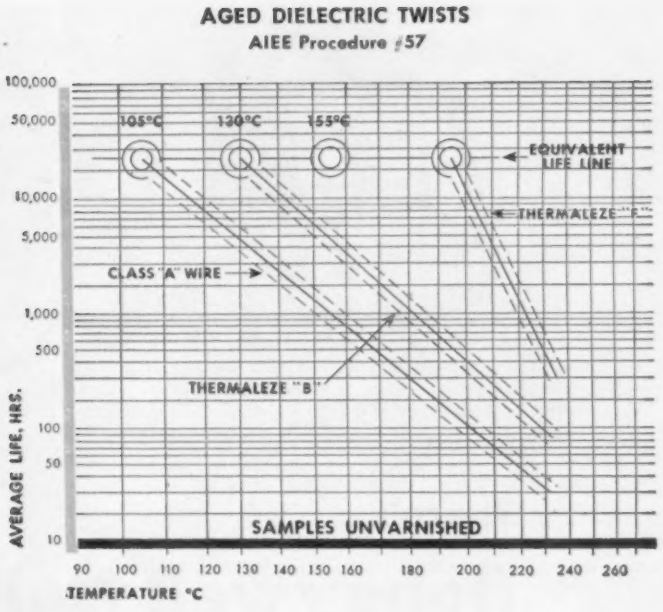
APPLIED RESEARCH TO MEET 155°C (CLASS "F")

THERMA



PHELPS DODGE

PERFORMANCE . . .



LEZE® F 155°C

- Dielectric twist performance establishes Thermaleze F as *exceeding Class "F" (155° C).*
- Better factor of safety because of improved "heat shock" characteristics.
- Good film flexibility under Class "F" conditions.
- Good balance of electrical, chemical and physical properties.
- Ideal for Class "F" stator windings and high temperature layer or random wound coils.
- Presently available in square and rectangular wire; also in round wire, sizes #8-40.

Any time magnet wire is your problem, consult Phelps Dodge for the quickest, easiest answer!

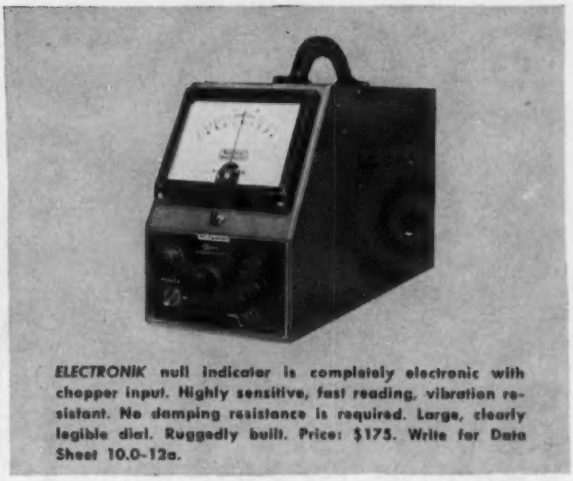
FIRST FOR LASTING QUALITY —FROM MINE TO MARKET!

PHELPS DODGE COPPER PRODUCTS CORPORATION

INCA MANUFACTURING DIVISION

FORT WAYNE, INDIANA

MAGNETIK null indicator with magnetic converter input. Can also be used as linear deflection indicator. Highly sensitive, isolated input, insensitive to d-c and a-c strays, and 60 cps series pickup. Mirror scale, vibration resistant. Price: $250, rack mounted version optional. Write for Bulletin NI-1.



ELECTRONIK null indicator is completely electronic with chopper input. Highly sensitive, fast reading, vibration resistant. No damping resistance is required. Large, clearly legible dial. Ruggedly built. Price: $175. Write for Data Sheet 10.0-12a.

There's a

Honeywell Null Indicator

. . . to fit your needs and your budget

RUBICON spotlight galvanometer with multiple-reflection optical system and 100-millimeter scale. Simple, sensitive, sturdy, linear. Sharp, parallax-free spotlight index. Insensitive to a-c strays. Price: $95 to $125. Write for Bulletin 320.

Here are three top quality null indicators, each with distinctive advantages for particular applications. Now you can choose the instrument with the exact characteristics you require, without paying for more than you need. Call your nearby Honeywell field engineer for details or write for literature.

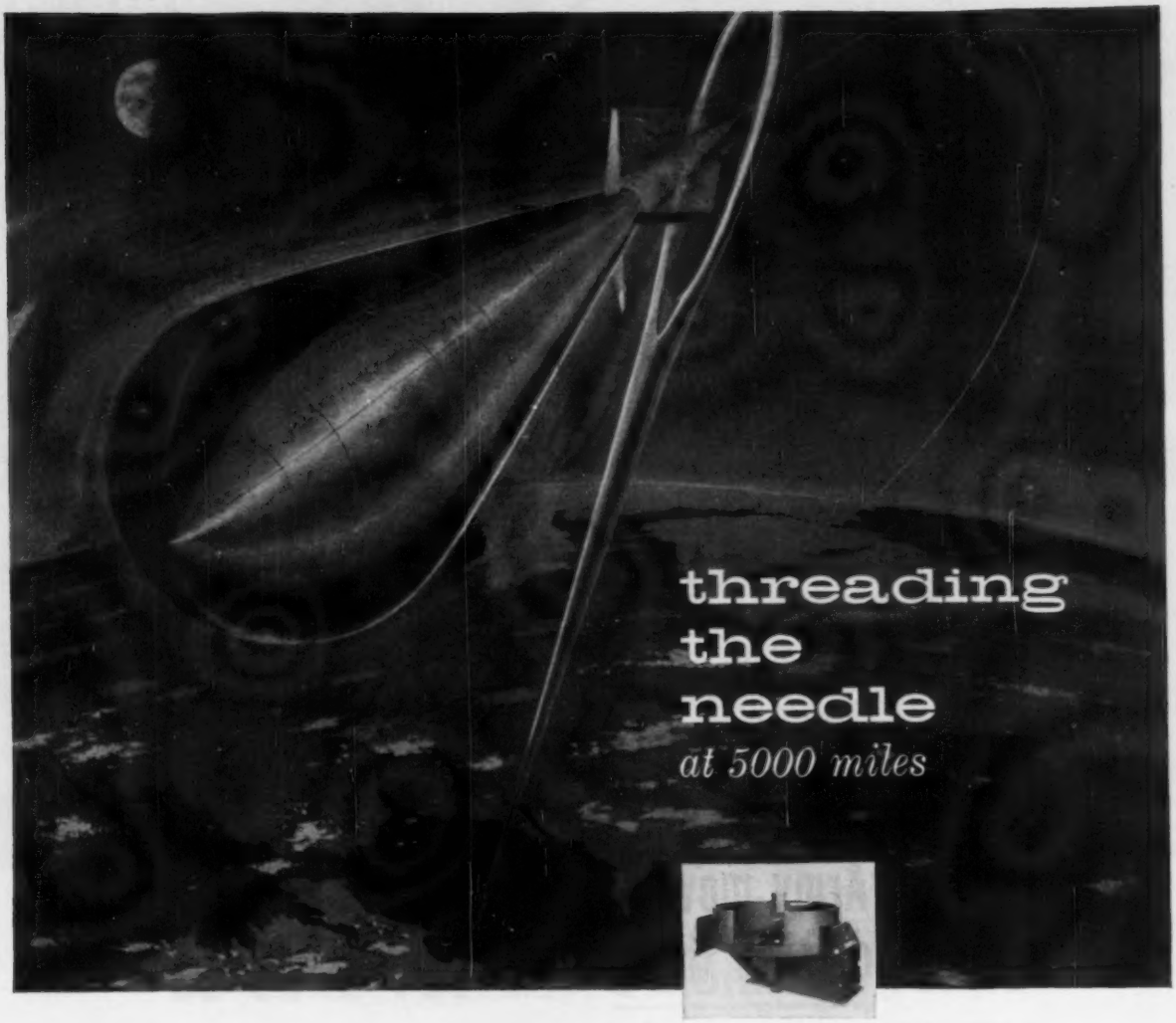
MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

SPECIFICATIONS

	MAGNETIK	ELECTRONIK	RUBICON
Voltage sensitivity	2 microvolts per division	1 microvolt per division	1.5 microvolts per division
Current sensitivity	.003 microamps per division	.001 microamps per division	.0006 microamps per division (max.)
Period	less than ⅓ second	Less than ½ second	from .6 to 5 seconds, depending on model
Input resistance	600 ohms at max. sensitivity	1000 ohms at max. sensitivity	13 to 4000 ohms, depending on model
Overload rating	10 volts, over-range to 45 volts	1.5 volt	10^5 x sensitivity
Zero drift	Less than 1 division per hour	Less than 1 division per hour	Negligible
Linearity	±5% of full scale	For null measurements only	±1% of full scale

Honeywell

H HONEYWELL *First in Control*



Genisco G-Accelerators play vital role in ICBM development

Threading the needle half-way round the world leaves no room for error.

Inertial guidance—self-contained guidance systems used to direct huge ICBM's to the target—depends for its accuracy upon the degree of internal instrumentation perfection. Switches, relays, delicate instruments, and hydraulic and electrical systems must operate perfectly—even while subjected to tremendous acceleration forces.

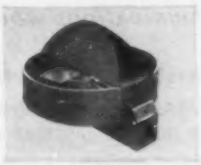
Testing components and complete asssemblies to simulated operational G-forces, as required by MIL-E-5272A, before relying upon their operation in actual flight is easily accomplished with Genisco's G-Accelerators.

Genisco's precision centrifuges are available in five standard sizes—from high-speed machines capable of high G-loadings, to large 12-foot diameter machines capable of accommodating complete electronic or electromechanical systems.

All models incorporate features necessary for critical laboratory testing, as well as the ruggedness and simplicity of operation required for production-line test programs.

Many automatic features minimize operator responsibility and chance for error. Built-in safety features and integrity of construction provide maximum protection to both personnel and machine.

Complete specifications on all machines and accessories are available. *Write, outlining your specific requirements.*



MODEL B78
Accommodates test objects up to 25 pounds; 1200 G-pounds max.

MODEL C159
Accommodates 100-pound test object on each end of boom; 2000 G-pounds max.

MODEL D184
Range of 1 to 800 G's; 1000 G-pounds max.

MODEL E185
Subjects two 300-pound assemblies to 100 G's. 30,000 G-pounds max.

Genisco

reliability first

2233 Federal Avenue,
Los Angeles 64, California

When the U. S. Army moves up Kleinschmidt is in the van

Kleinschmidt page printers and reperforator teletypewriters receive and transmit teleprinted communications wherever a truck can roll.

As division headquarters advances in the field, it is imperative that communications with outlying units be maintained without interruption. Kleinschmidt teletypewriters and related equipment, installed in a U. S. Army cargo truck and transmitting by radio, provide a message center that meets every demand of mobility and dependable two-way communications. These Kleinschmidt units, developed in cooperation with the U. S. Army Signal Corps, furnish sender and recipient with an identical teleprinted original, eliminating misinterpretation and speeding the required action.

Research and development of equipment for transmitting and receiving printed communications has been a continuing project at Kleinschmidt for almost 60 years. This unparalleled store of experience, now joined with that of Smith-Corona Inc, holds promise of immeasurable new advances in electronic communications.

KLEINSCHMIDT LABORATORIES, INC.

PIONEER IN TELEPRINTED COMMUNICATIONS EQUIPMENT

A SUBSIDIARY OF SMITH-CORONA INC • DEERFIELD, ILLINOIS

BEYOND ACCEPTED STANDARDS OF TUBE RELIABILITY. 50,000 high-reliability tubes at a time—a half million a month—receive a special burn-in at General Electric's 5-Star factory. Tube performance is stabilized. Early-life inoperatives are weeded out. Every G-E 5-Star Tube also has passed rigid mechanical and electrical tests before shipment.

OPERATION upturn — Buy now for extra values — GENERAL ELECTRIC

BE SURE YOU GET STABILIZED TUBES WHEN YOU PAY FOR HIGH RELIABILITY!

Only General Electric stabilizes all high-reliability tubes by factory burn-in. What does this 5-Star process mean to you, a manufacturer of electronic equipment with critical sockets?

It's extra protection against production-line shutdowns in your plant, because stabilizing helps weed out any early-life tube inoperatives. Likewise, it's a special safeguard that your radar, communication, or other equipment will prove dependable from the start, when placed in service.

Stabilizing also promotes more uniform tube performance . . . your designers can count on 5-Star Tubes meeting rated requirements at all times. This helps assure that your equipment will continue to perform reliably—building a solid reputation that will lead to repeat orders for new equipment.

When you specify high-reliability tubes, be sure you get the superior quality that only General Electric *stabilized* 5-Star tubes offer! Any G-E Receiving Tube Department office listed below will be glad to supply further information. Phone today!

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200 Main Ave., Clifton, N. J.	3800 N. Milwaukee Ave.	11840 W. Olympic Blvd.
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(Clifton) GRegory 3-6387	Phone: SPring 7-1600	Phones: GRanite 9-7765
(N.Y.C.) WI. 7-4065, 6, 7, 8		BRadshaw 2-8566

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12-11-204

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SWEEPING OSCILLATORS for RADAR and TELEMETERING IF's 1-1,200 mc by

KAY ELECTRIC

Kay *Vari-Sweep* 860-A

The Kay sweeping oscillators are a line of high level lab and field test instruments designed for the alignment of radar and telemetering IF strips from 1 to 1,200 mc. The line offers a wide choice of precision-built units which are simple to operate, highly stable, and extremely flexible.

- **Wide Range, Wide Sweep**
- **High Output**
- **Fundamental Frequency**
- **Constant Output (Fast-Acting AGC)**
- **Continuously Variable Centers**
- **Fixed, Crystal-Controlled Markers**
- **All Electronic Operation**

Instrument	Cat. No.	Range	Sweep Width	RF Output	Markers	Price†
Vari-Sweep	860-A	2-220 mc (center)	Contin. Variable to 60% center freq. below 50 mc; 30 mc plus, above 50 mc.	1.0 V rms AGC'd, 70 ohms	None	$695.
Vari-Sweep Model IF	866-A*	4-120 mc (center)		1.0 V rms AGC'd, 70 ohms	11 Fixed Crystals 1 Variable. Direct reading dial	$950.
Vari-Sweep Model Radar	865-A*	10-145 mc (center)		1.0 V rms AGC'd, 70 ohms	11 Fixed Crystals 1 Variable. Direct reading dial	$950.
Vari-Sweep Model 400	867-A	15-470 mc in 10 bands	Same as above to 400 mc; 20 mc max. above 400 mc.	1.0 V rms into 70 ohms to 220 mc; 0.5 V rms to 470 mc; all AGC'd	None	$795.
Mega-Sweep	110-A**	50 kc-950 mc	50 kc-40 mc	100 mv at 50 ohms	None	$495.
Kada-Sweep	380-A*	2 Switched bands 20-40 mc; 50-70 mc	2 Switched bands, Wide 20 mc, Nar. 3 mc	250 mv rms, 70 ohms	9 Fixed Crystals	$395. (with 4 crystals)
Kada-Sweep 300	386	Between 1 & 350 mc center	70% of center to 100 mc; 60-70 mc to 350 mc	0.5 V rms into 70 or 50 ohms,	Up to 30 crystal pulse marks	$695. plus $15. per marker ordered

**Other Mega-Sweeps to 1200 mc; and with Markers.

*Wider sweep widths, additional crystal markers available on special order.

† All prices F.O.B. Pine Brook, N. J.

Write for 1958 Kay Catalog

KAY ELECTRIC COMPANY

Dept. E-8 Maple Avenue, Pine Brook, N. J. CApital 6-4000

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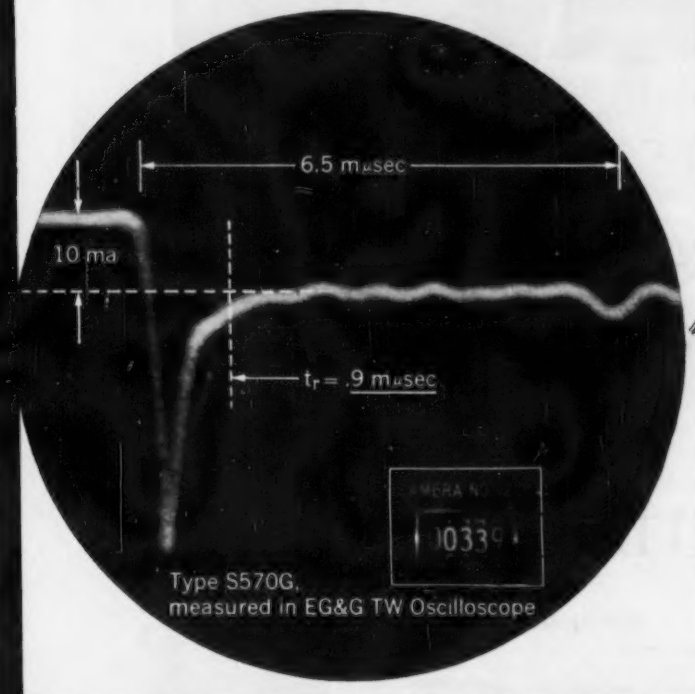
NOW...from Transitron the world's FASTEST DIODES for milli-microsecond switching!

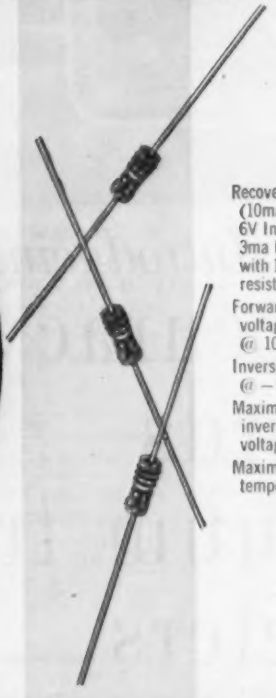
Here at last are diodes suitable for extremely high speed transistorized computer circuitry. These diodes offer you the convenience and simplicity of conventional types — but they are on the order of *50 times faster!* Produced and priced for computer use, they are intended for critical applications at normal transistor bias levels.

The S570G germanium diode has optimized switching characteristics in the region below 10 milli-microseconds. Total stored charge after a 10ma forward current is less than that of a 3pf (micro-microfarad) capacitor at 6 volts! Germanium type S555G obtains better D.C. characteristics at some sacrifice of speed. The S266G is a bonded silicon diode intended for use in high temperature high speed equipment. Low leakage current makes it useful also as a pulse stretcher. It is typically faster than any of the presently available silicon diffusion diodes and silicon transistors.

These new diodes can reduce the number of transistors in circuits. They may be used to simplify coupling and logic design, reducing dependence on critical timing and synchronization. For example, difficult DCTL circuits may be made DCDTL with no loss in speed. *Available now*, these diodes will open many new frontiers.



Type S570G, measured in EG&G TW Oscilloscope



	GERMANIUM		SILICON
	S570G	S555G	S266G
Recovery time (10ma $I_{fwd.}$ 6V Inverse to 3ma Inverse with 120 ohms resistive load)	.002	.006	.004 μsec max.
Forward voltage drop @ 10ma	1.0	.5	1.5 volts max.
Inverse current @ −6 volts	30.0	10.0	1.0 μa max.
Maximum inverse voltage rating	6.0	15.0	8.0 volts
Maximum temperature	75	75	150 °C

Transitron

electronic corporation wakefield, massachusetts

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..... *Introducing*

new accuracy standards to vacuum tube voltmeters

Modern electronic research often requires DC and AC VTVMs which have accuracies substantially better than 1%; in addition, accurate AC VTVMs are needed which measure RMS values, rather than average or peak.

Two new Millivac precision voltmeters fulfill these conditions. The MV-57A DC-VTVM has ¼% accuracy, based on a built-in standard cell reference. Price: $790.00.—The MV-32A RMS voltmeter has ½% accuracy; its RMS response is based on an electronically protected vacuum thermocouple. Price: $890.00.

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WESCON SHOW

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INSTRUMENTS
Division of Cohu Electronics, Inc.
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TOMORROW IS OUR YESTERDAY

50 ohm Coax Terminations dc to 4 KMC!

8 new instruments!
1 to 500 watts coverage!

New Sierra 160 series Coaxial Terminations are ideal for use with directional couplers, or in other applications requiring wide frequency range and low VSWR. They provide extremely high stability, and will dissipate full rated power continuously up to an ambient temperature of 40°C. Derating permits operating at still greater ambient temperatures. Terminations are completely shielded, and may be used to adjust transmitters without radiation. They are also useful for converting Sierra Bi-Directional Power Monitors to a termination type wattmeter.

SPECIFICATIONS

Model	Power*	Connectors	VSWR
160-1F 160-1M	1 watt 1 watt	Type N fem. Type N male	Less than 1.10, dc to 4 KMC.
160-5F 160-5M	5 watts 5 watts	Type N fem. Type N male	Less than 1.08, dc to 4 KMC.
160-20F 160-20M	20 watts 20 watts	Type N fem. Type N male	Less than 1.10, dc to 1 KMC; Less than 1.15, up to 4 KMC.
160-100F	100 watts	Type N fem.	Less than 1.2, dc to 4000 MC.
160-500F	500 watts	Type N fem.	Less than 1.2, dc to 3400 MC.

Up to 40° C ambient.

New LOW PASS FILTERS

Sierra 184 series Low Pass Filters have an insertion loss not more than 0.4 db in pass band, sharp cut-off, 1.5 VSWR or less, and rejection greater than 60 db from 1.25 to 10 times cut-off frequency. Five models: for cut-off frequencies of 44, 76, 135, 230, 400 MC. Power range 250 watts in pass band, 25 watts in rejection band.

Write for Bulletin!

sierra

Sierra Electronic Corporation

A Subsidiary of Philco Corporation

3663A Bohannon Dr., DAvenport 6-2060, Menlo Park, Cal., U.S.A.

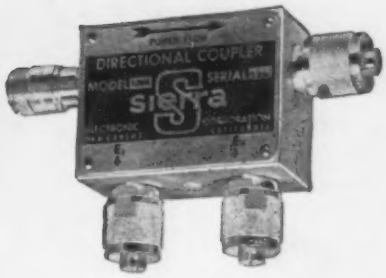
Sales Representatives in major cities

CANADA: Atlas Radio Corp., Ltd., Toronto, Montreal, Vancouver, Winnipeg

EXPORT: Frazar & Hansen, Ltd., San Francisco, New York, Los Angeles

sierra

WIDEBAND DIRECTIONAL COUPLERS



Versatile, accurate Sierra couplers are offered in 6 models for frequencies 10 kc to 2000 mc. Couplers provide transmission line measurements including reflection coefficient, VSWR, power. Also permit matching of loads to lines dynamically by indicating conditions providing minimization of reflected voltages. Request Bulletins 101, 104.

Coupling Factor: (in db ± 1 db)

Model	10 kc	3 mc	10 mc	30 mc	100 mc	300 mc	1000 mc	2000 mc
137, 137A				73	63	53	43	37
138, 138A				59	49	39	29	
145		52	42	32	22	12		
150				53	43	33	23	
139	50	50						

Directivity: 12 db ± 3 db greater than coupling factor at each frequency.

Impedance: Models 137 and 138 are 51.5 ohms. Models 137A, 138A, 145 and 150 are 50.0 ohms. Model 139 may be matched to most impedances.

Power: Usable to 1000 watts throughout frequency range.

SIERRA 148 CRYSTAL DETECTOR

Insures sensitive readout for Sierra Directional Couplers. Low VSWR, high sensitivity to 1200 MC. 50 ohm input impedance, filtered output. Type N input, BNC output connectors.

3663-C

Data subject to change without notice

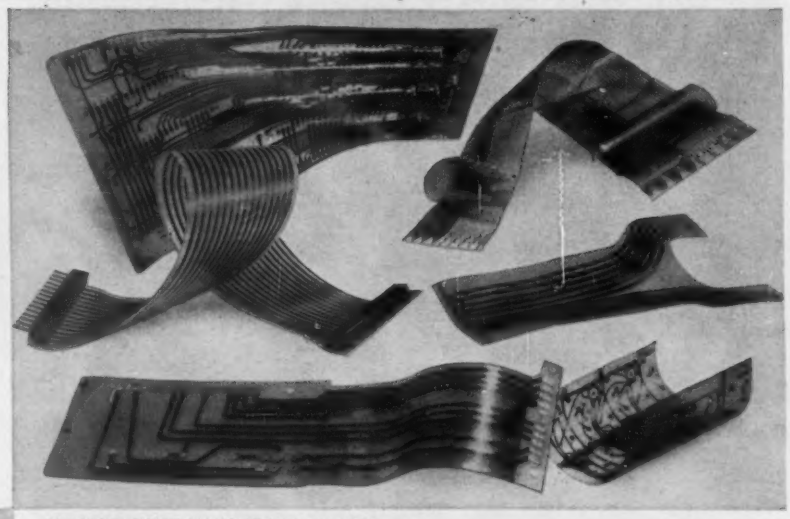
From Sanders Associates, Inc., Nashua, New Hampshire . . .

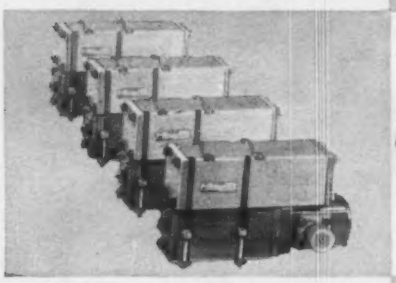
RELIABILITY-PROVED COMPONENTS FOR AIRCRAFT, MISSILES, SPACECRAFT

FLEXIBLE PRINTED WIRING

Sanders *Flexprint*Ⓣ Printed Circuit Cables and Harnesses sharply reduce the weight, space and cost of electronic and electrical assemblies . . . eliminate wiring error. Conductors are permanently bonded in thin sheets of flexible plastic: vinyls, polyethylenes, polyesters, silicones, Kel-F or Teflon. All lengths and current carrying capacities. Meets military reliability requirements.

Ⓣ TRADEMARK — SANDERS ASSOCIATES, INC.



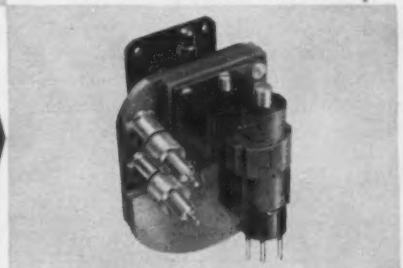


ELECTRO-HYDRAULIC SERVO VALVES

Two-stage internal force-feedback principal converts low input power to high output flow. Valves feature high frequency response and resolution, low threshold, and high internal stiffness of control over the operating range of −65°F to 225°F. Large-area internal filters in pilot stage assure reliability. Standard flow ranges up to 0-200 gpm (at 1000 psi pressure drop); supply pressures to 3000 psi.

MICROWAVE TRANSMISSION LINE

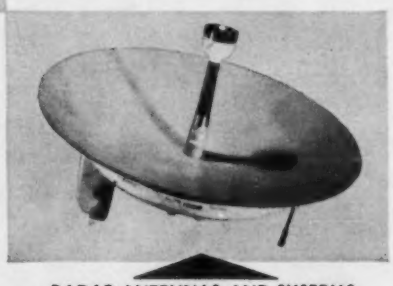
Sanders *Tri-Plate*® Strip Transmission Line offers broad band operation within the frequency range 100 to 12,400 mc with substantial savings in size, weight, and cost over conventional coaxial and waveguide assemblies. Components in use include variable attenuators, balanced mixers, hybrid rings, directional couplers, low pass filters, power dividers, and receiver and beacon front ends.



KEY COMPONENTS PRODUCED BY SANDERS ASSOCIATES offer advantages of unfailing dependability . . . savings in space and weight . . . superior performance for your guidance, control, and detection systems. They are available in production quantities and may be readily adapted to meet special requirements. Sanders also offers complete creative engineering, design, development, and production services with highly specialized experience, skills, and manufacturing facilities in electronics, hydraulics, and electromechanics. Sanders can produce individual components or complex packaged systems capable of meeting extreme environmental and performance requirements.

CONSTANT DAMPING RATE GYRO

Sanders Subminiature Rate Gyroscope, Type RGB, has a nominal damping ratio of 0.5 ±0.1 between −30°C and +100°C. Simplified damping mechanism compensates for temperature changes without linkages. Features include: lifelong hermetic sealing, excellent resolution, high sensitivity, small size (15/16" D x 2½" L), lightweight. Input rates up to ±1000 deg/sec.



RADAR ANTENNAS AND SYSTEMS

Sanders *Tri-Scanner*® Conical Scan Antenna provides three-times the information rate of conventional fire control antennas. In use on a major missile system, it is lightweight and statically and dynamically balanced, and offers unusual anti-jam features. Sanders also manufactures photoetched slot and spiral antennas for flush-mounted arrays, beacons, and communication systems.

Call or Write:

SANDERS ASSOCIATES INC.

NASHUA, NEW HAMPSHIRE • Dayton, Ohio • Inglewood, California • Washington, D.C.

COMPUTERS

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for 20 years.....

computers and controls

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SOLUTION TO COMPLEX COMPUTING PROBLEMS are among Librascope's accomplishments as represented by a formidable array of computing equipment. Our selection of the most effective computing solution to meet a problem is based on twenty years of experience gained in the development and manufacture of mechanical, electrical, electronic and magnetic computing devices. Computers for both military and commercial purposes are developed and manufactured by Librascope. Inquiries on computing control problems are welcome.

Engineers capable of significant contributions are invited to write Glen Seltzer, Employment Manager.

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This is the Magnet Wire with the extras.....

SX®

21 different basic insulations

84 different insulation constructions

100,000+ different types and sizes

(in round, square and rectangular fabric and film coated magnet wires)

Add them up! EXTRA care in drawing and annealing—EXTRA care in insulating techniques! EXTRA rigorous "in-process" testing of wire from every machine each day plus 100% final inspection! EXTRA quick identification of size and type on easy-to-read, color coded labels . . . and EXTRA attention to packaging (spool, reel, and Magna-Pak®) at each of the four plants.

MAGNET WIRE DIVISION, Essex Wire Corp., Fort Wayne 6, Indiana

Manufacturing Plants: **Birmingham, Alabama; Anaheim, California; Fort Wayne, Indiana; Hillsdale, Michigan**

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NATIONAL NETWORK OF WAREHOUSES AND SALES OFFICES . . . CALL YOUR LOCAL "ESSEX MAN"

Here's the "workhorse"

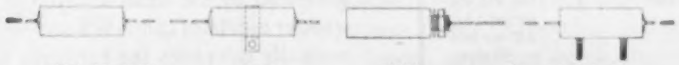
GOOD-ALL
Metal Enclosed Capacitors are first choice of more and more engineers

Today, "CP" styles per the MIL-C-25A are the "WORK-HORSE" capacitors of military electronics. Soon, new specifications such as MIL-C-0025 (USAF) and MIL-C-25B will exert their influence . . . but regardless of the specification number, more and more engineers specify GOOD-ALL for their preferred sources. There are sound reasons why high quality is consistently maintained.

HERE'S WHY ENGINEERS ARE CHOOSING GOOD-ALL

- **Well engineered designs**
- **Skilled assembly personnel**
- **Modern production facilities**
- **Rigid Quality Control**

Good-All Specializes in these tubular types per MIL-C-25A



CP04-05-08-09 CP10 CP11 Special variations

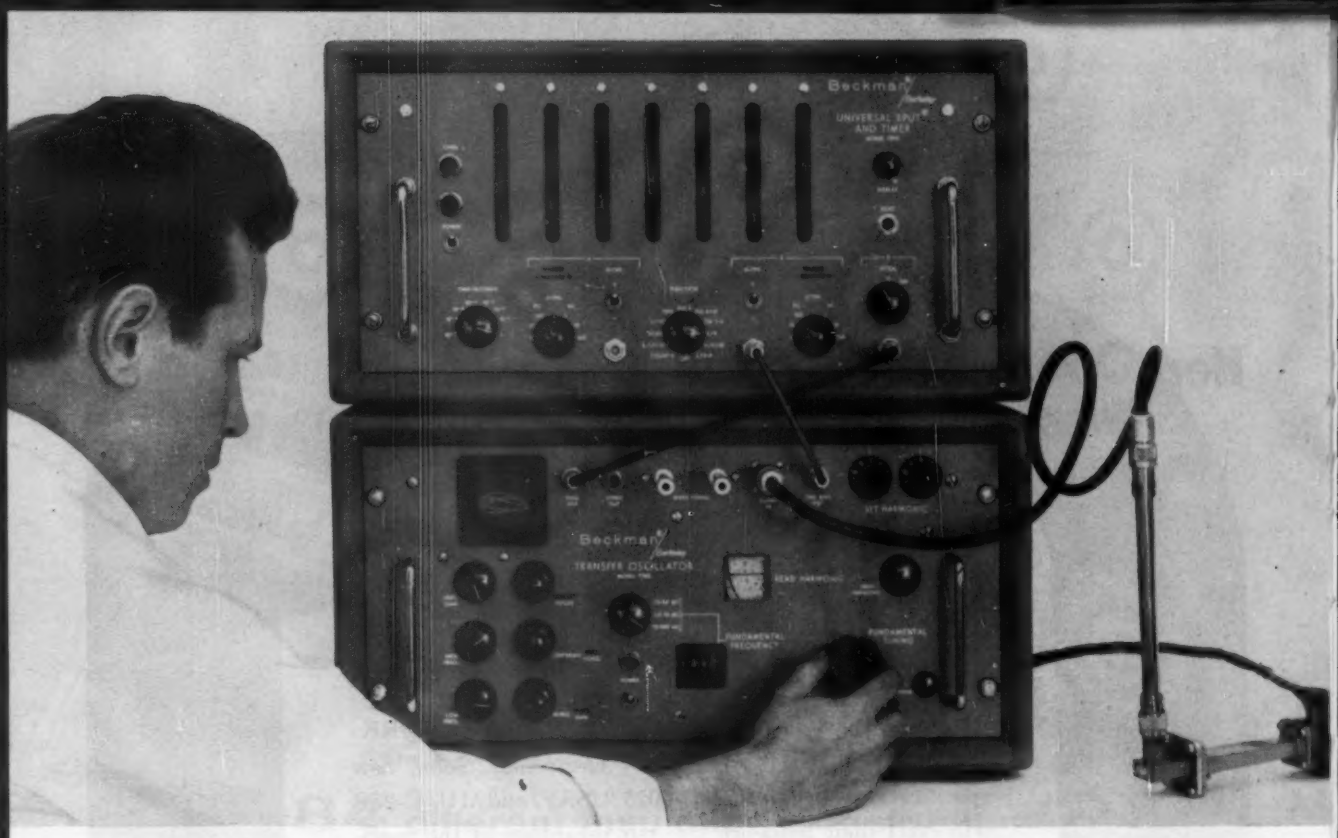
All popular values are available in stock for immediate delivery.

Good-All tubulars per MIL-C-25A now available at leading industrial distributors.

Good-All
CAPACITORS

GOOD-ALL ELECTRIC MFG. CO.
OGALLALA, NEBRASKA
A LEADING MANUFACTURER OF TUBULAR CERAMIC DISC AND ELECTROLYTIC CAPACITORS

In Canada, 700 Weston Road, Toronto 9, Ontario



12,000 Mc

directly displayed by a counter

Model 7580 Transfer Oscillator (bottom cabinet) with Model 7370 EPUT and Timer (top cabinet):

Frequency measuring range	dc to 12 K Mc
Types of signals accommodated	CW, AM, FM pulsed r-f
Sensitivity	100 mv rms
Input impedance	50 ohms
Accuracy	up to $\pm 3p$ in 10^7
Fundamental range of trans. osc	75 to 150 Mc & 7.5 to 15 Mc
Harmonics available	Up thru 80th
Stability of fundamental	.0001%/min

Four-step operation:

1. Tune to two adjacent zero beats identified by built-in oscilloscope display.
2. Read harmonic number on calculator dial.
3. Set rotary switches to harmonic number.
4. Read frequency indication directly from counter.

Prices: Model 7580 Transfer Oscillator . . . $1650
Model 7370 10 Mc EPUT & Timer . . . $1975
Model 7360J 2 Mc EPUT & Timer (price $1325) may also be used with the transfer oscillator.

158

Used in combination with the computing transfer oscillator in the cabinet beneath it, the 10 Mc EPUT® and Timer creates a *direct* decimal display of 12,243.15 megacycles generated by the small klystron at the right. How? The transfer oscillator contains a computing device which automatically calculates the harmonic number of a harmonic brought to zero beat with the frequency under test. Then, the gate time of the counter is multiplied by the harmonic number to produce a counter indication of actual klystron frequency. By eliminating all manual computations, the entire operation commonly takes less than one-fifth the time required using equipment previously available.

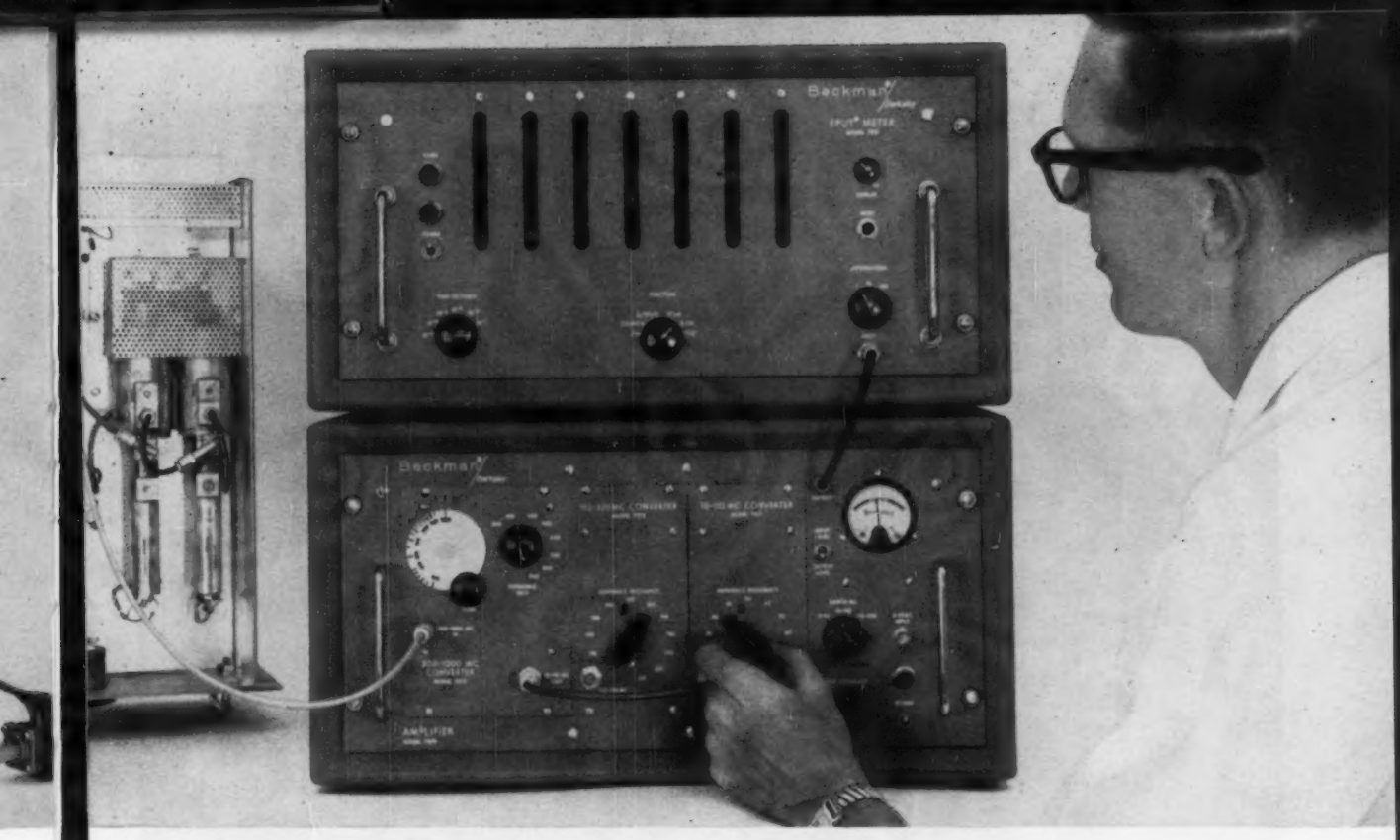
This assembly of two independent units, compatibly designed, offers an unprecedented combination of range, accuracy and convenience. The transfer oscillator can also be used with either of two other BECKMAN/Berkeley EPUT Meters currently in wide use.

For more information on this and other recent advances in digital frequency measuring techniques, write for the new Data File 111. Address department G-8.

Beckman®

Berkeley Division
2200 Wright Avenue, Richmond 3, California
a division of Beckman Instruments, Inc.

CIRCLE 56 READERS SERVICE CARD



Heterodyne converters extend range of EPUT® Meter to 1000 Mc

Model 7570 Series Amplifier & Converters (bottom cabinet) used with Model 7170 EPUT Meter (top cabinet) or with Model 7370 EPUT & Timer (not shown).

Frequency measuring range with EPUT meter:

Model 7571 converter only	dc to 110 Mc
7571 & 7572 converters	dc to 220 Mc
7571, 7572 & 7573 converters	dc to 1000 Mc

Sensitivity (rms) & input impedance:

dc to 10 Kc	100 mv into 1M ohm
10 Kc to 10 Mc	1 mv into 1M ohm
10 Mc to 220 Mc	10 mv into 50 ohm
220 Mc to 1000 Mc	1 mw into 50 ohm

Video amplifier:

All converters are installed in the Model 7570 cabinet which includes a video amplifier used independently to increase the sensitivity of the counter. See 10 Kc to 10 Mc sensitivity above.

Prices:

Model 7570	$300	Model 7573	$ 500
Model 7571	$250	Model 7370	$1975
Model 7572	$250	Model 7170	$1675

189

Shown above measuring the output frequency of a 1000 Mc cavity resonator is a full complement of frequency converters operated with a 10 Mc counter. The bottom cabinet *permanently* houses all three converters covering the full range from 10 Mc to 1000 Mc. Initial requirements for a more limited range can be accommodated by installing only one or two converters – without affecting the ease of future expansion. Extraordinary sensitivity (see specs.) insures that loading effects will not distort measurements of weak signals.

Measurements are extremely easy to make. No tuning is required up to 220 Mc. Simply select range, couple signal, adjust output level with aid of "low-satisfactory-high" meter and read counter indication, adding reference frequencies. Percentage accuracy exceeds that of counter alone.

For more information on this and other recent advances in digital frequency measuring techniques, write for the new Data File 111. Address department G-8.

Beckman®

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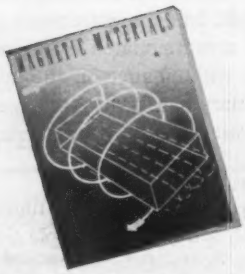

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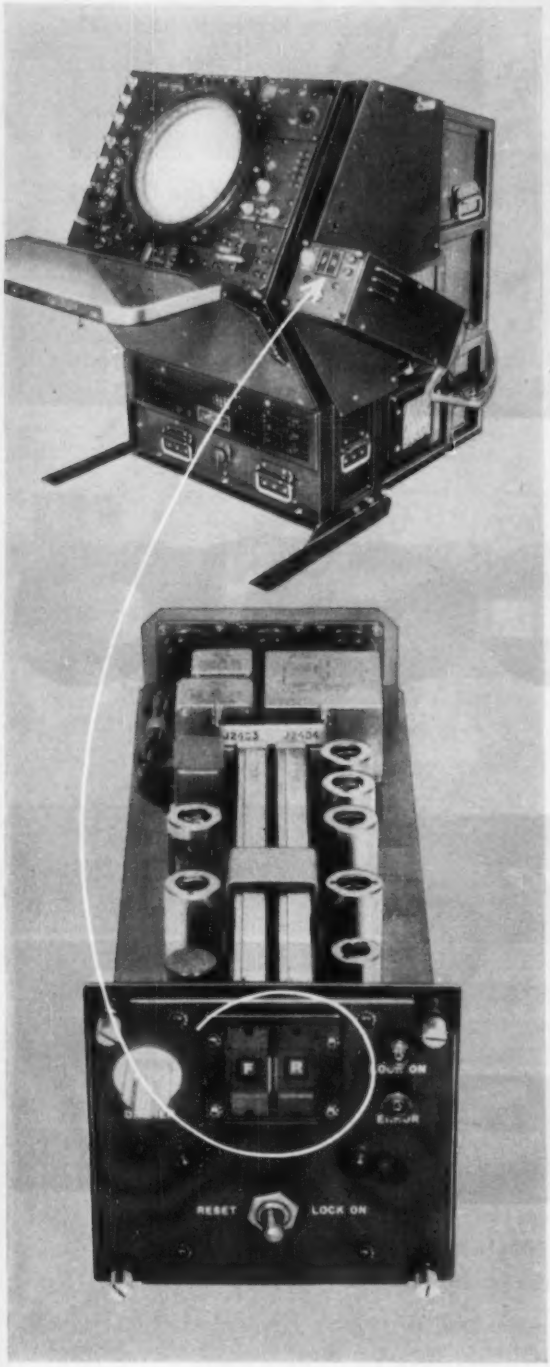

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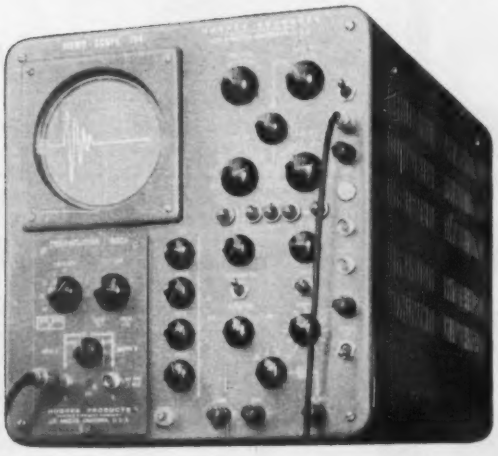

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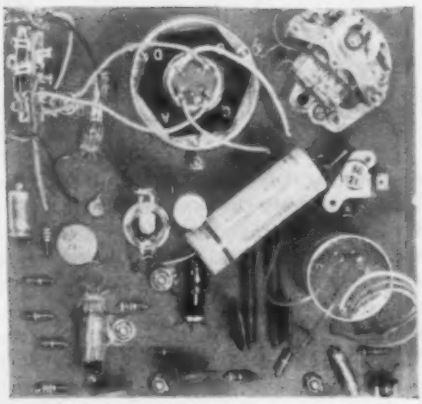
Detection unit is checked out with clock calibrator shown at right



Automobile clock mounted at upper right

Determining Arrival Time of Radioactive Fallout

Standard electric automobile clock operates until fallout at levels greater than 2 milliroentgens per hour arrives. At that time Geiger-counter detection circuit blows power-supply fuse causing clock to stop with hands indicating time of arrival of fallout. Instrument will operate for about four weeks on self-contained batteries and regulated transistor high-voltage power supply

By ROSS W. FARMER and OSCAR REINER, JR.,
School of Medicine, The University of California, West Los Angeles, California

STUDY OF PROBLEMS associated with fallout required that the time of arrival of the radioactive material at a given location be known.

Lack of a commercially available instrument for this purpose resulted in the development of the device to be described. The unit incorporates its own power supply and can be operated unattended for a period of about four weeks.

The unit is shown in block form in Fig. 1 and schematically in Fig. 2.

Time is indicated by a conventional current-pulse driven 6-v automobile clock that operates until the fallout arrives. The circuit controlling the clock contains a one-shot multivibrator which is triggered by pulses from the Geiger tube. The meter relay in the multivibrator output circuit indicates average current and, therefore, the count rate.

The relay contacts are adjustable to permit sensing of a predetermined radiation level. When the radiation reaches this level an auxiliary relay is actuated, whose contacts present a short to the battery circuit. This overload blows the fuse in the battery circuit, thereby inactivating the electronic circuit and the clock.

Resistor R_1 (Fig. 2) is individually selected in each instrument to compensate for variations in other

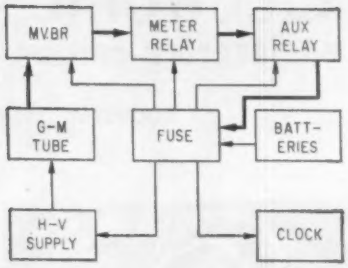


FIG. 1—Block diagram shows how blowing of fuse deactivates clock and circuits

components, thus enabling all units to show roughly the same deflection for the same radiation level. Extreme accuracy of calibration is not necessary since the position of the adjustable contact is determined with a standard radiation source.

The fuse is used here only as a means of inactivating the instrument and not as a safety device. Since the fuse is in a circuit which is common to the counting circuit, the high-voltage supply and the clock, the effect of electrical noise currents generated by the high-voltage supply or the clock are introduced into the counting circuit in proportion to the resistance of the fuse. For this reason, it is desirable to use a low resistance fuse (high current carrying capacity).

During development of the circuit, use of a fuse of just sufficient capacity to safely carry the normal current of the circuit caused the instrument to have a high residual count rate. The use of a fuse-blowing device instead of a latching relay or other shut-off device reduced the cost of the instrument appreciably.

The auxiliary relay obtains its power from the same source which its contacts short circuit. Ordinarily this would tend to make the relay oscillate, particularly if the battery is nearing the end of its life. To prevent this, the circuit is arranged so that when the relay operates, it disconnects itself from the battery and remains energized for 1 or 2 sec by the charge stored on the 1,000-μf capacitor. This time exceeds by a wide margin the time necessary to blow the fuse.

High-Voltage Supply

The Geiger tube used in the instrument requires a 900-v potential. The application requirements indicated that a power supply was more desirable than batteries to supply this voltage, since the 6-v battery necessary to operate the clock was also available to operate the power supply.

It was determined that the cost of components for the power supply was slightly less than the cost of the initial set of three 300-v batteries. In many cases, early failure of a 300-v battery has been due to a single defective cell. As there are 200 cells in each battery, the probability of early failure was considered excessive. It was also thought that early cell failures would be aggravated by the high temperatures encountered, which tend to dry out the electrolyte.

An outstanding advantage of the power supply is its regulated output voltage which is independent of battery age. The input section of the power supply, a transistorized Hartley oscillator, is followed by a transformer whose primary acts as the resonant circuit of the oscillator. The secondary delivers approximately 450-v rms to the voltage-doubler rectifier.

The 1,200-v output of the rectifier

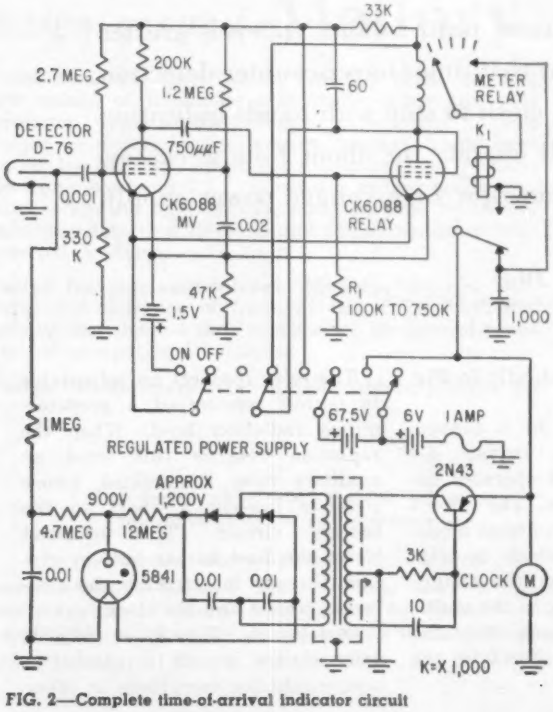


FIG. 2—Complete time-of-arrival indicator circuit

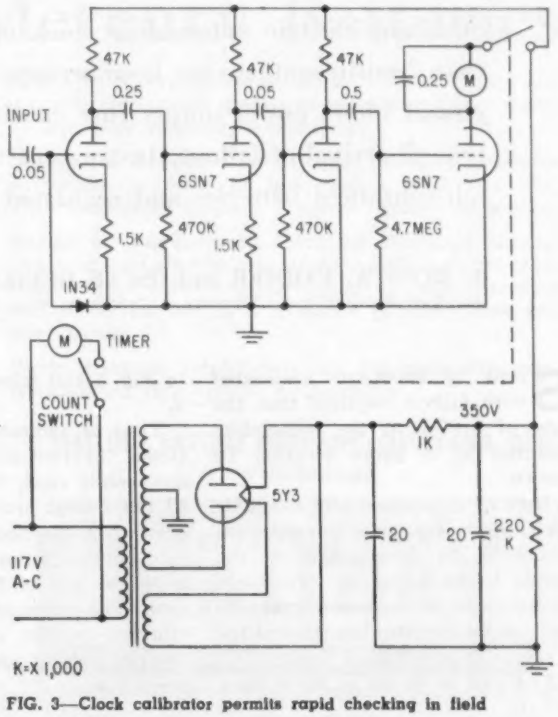


FIG. 3—Clock calibrator permits rapid checking in field

is dropped to 900 v by a corona-discharge tube. This regulator permits the output of the rectifier to drop to 900 v before the output voltage will change, corresponding to a drop in battery voltage of 25 percent.

The Geiger tube used has a brass shell and was selected for ruggedness and economy. It will detect beta and gamma radiation of 0.4 mev or greater.

In spite of the metal shell, the tube was found to be light sensitive due to the glass beads in the ends of the tube which support the anode. After coating these beads with black lacquer no further trouble was encountered. The corona discharge regulator tube was also found to be light sensitive and was coated with black lacquer.

Performance

One instrument was successfully tested at a low temperature of 38 F for 24 hours and at a high temperature of 136 F for 8 hours. If the units are to be used at more extreme temperatures further tests will be necessary with particular attention being paid to the operation of the batteries.

The prototype unit was placed out of doors with no shelter and allowed to run until it failed as a result of battery exhaustion. It operated continuously for approximately one month on the original set of batteries which had been used to develop the circuit in the laboratory.

It is conservatively estimated that during this test the ambient temperature varied from 45 F on certain nights to 95 F on certain days with the maximum temperature inside the unit exceeding this value considerably because of direct sunlight. The unit also experienced at least one night of rainfall with no apparent effect.

Where available, test reports furnished by suppliers of components were also used to evaluate reliability as a function of temperature. A report furnished by the clock mechanism manufacturer stated that the timing accuracy was within ±1 min a day for a voltage variation from 4 to 7.5 v. It was also stated that timing accuracy would be within 1 min a day for temperatures variations between −20 F and +130 F. The manufacturer of the high-voltage transformer tested a working model of the high-voltage supply circuit used in the instrument over a temperature range of 5 F to 130 F, and obtained satisfactory operation.

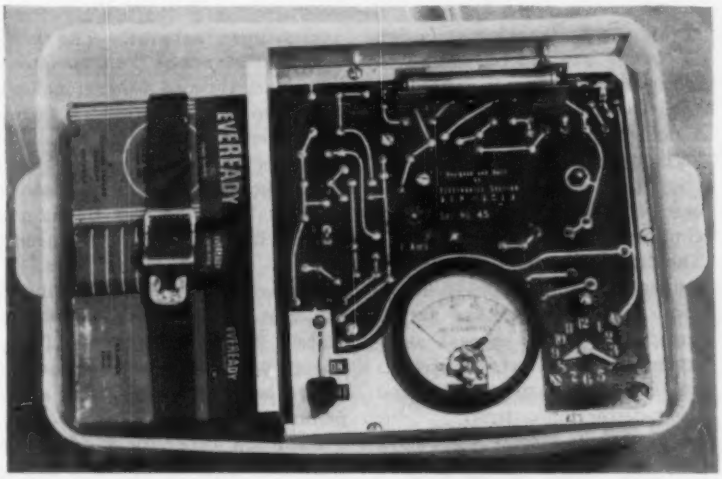
In actual field operation, these instruments have been transported over many hundreds of miles of unimproved roads and have performed with a minimum of service and repair.

Clock Calibrator

Because of the adverse conditions under which the time of arrival indicators are operated in the field and because of the importance of timing accuracy it was necessary to devise a means of recalibrating the clock mechanisms at a field laboratory. To avoid calibration by observation over a period of hours and by repeated trials, the clock calibrator of Fig. 3 was developed.

As a pulse of current is delivered to the driving coil of the clock on each beat, a convenient means is provided for electronically sensing the accuracy of the clock. The input leads of the calibrator are clipped across the driving coil of the clock. The signal thus obtained is shaped by the diode grid load of the first stage of the conventional four-stage R-C amplifier. A mechanical register located in the plate circuit of the final stage totalizes the number of beats.

Power is applied to the electric timer at the same time the circuit is completed to the mechanical register. The clock, when correctly calibrated, operates at the rate of 300 beats per min. To obtain the required accuracy it is necessary to time a clock for at least 5 min (300 sec) to minimize inaccuracies caused by starting and stopping the run. This period should result in an accumulation of exactly 1,500 counts; the deviation from the 1,500 count is roughly equal to the number of minutes gained or lost in 24 hours.



Circuit is contained on 7-by 7½-in. board that mounts, along with batteries, in polyethylene food-crisper container

The authors acknowledge the continuing interest shown in this problem by the members of the Environmental Radiation Division. Peter Kalian of the Photographic Section assisted greatly in developing the procedure for producing the printed circuit boards and the Shops Section contributed greatly in developing the optimum form for the chassis.

This article is based on work performed under Contract No. AT-04-1-GEN-12 between the Atomic Energy Commission and the University of California at Los Angeles.

Single diffused-base transistor converter has only one variable tuning element in band-pass circuit. Last of three transistor i-f stages is reflexed as emitter-follower amplifier to provide audio gain and low output impedance. Ratio detector has 700-kc peak separation for low distortion and high a-m rejection

By **HARRY COOKE,** Circuit Development Branch, Texas Instruments Inc., Dallas, Texas

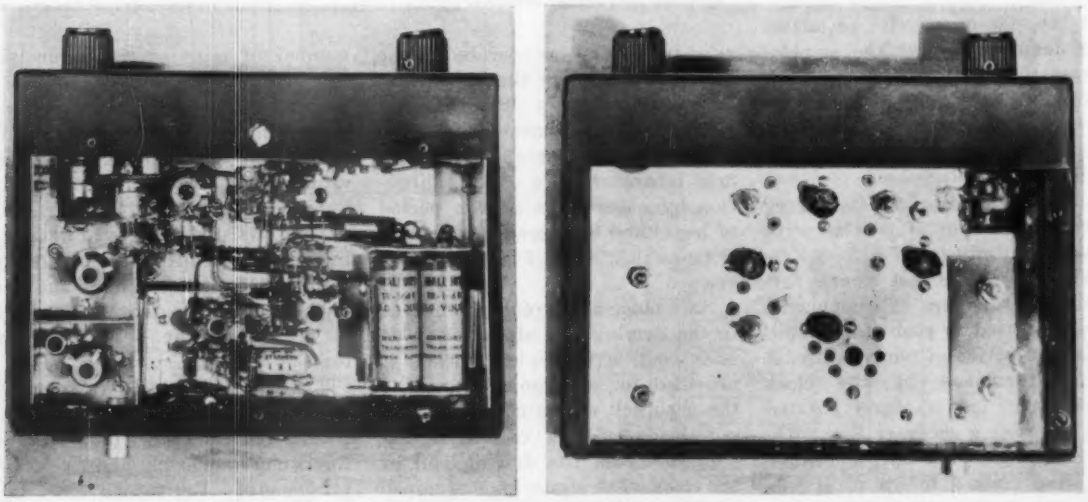
F-M Tuner Uses

FRONT END tracking and alignment is one of the more time consuming operations in the construction of a superhetrodyne tuner. The f-m tuner to be described incorporates a single transistor converter with only one variable tuning element to simplify tracking and alignment. The last of three i-f stages is reflexed as an emitter-follower audio amplifier with low output impedance. A 700-kc peak separation ratio detector provides relatively high a-m rejection and a low-distortion output.

The input circuit shown in Fig. 1 is a transistionally coupled series-tuned network. The low input resistance of the transistor with this type of tuning makes the required circuit values more convenient to work with. In addition, series tuning exhibits an impedance rise outside of resonance that is necessary to maintain oscillation over the required 113 to 133-mc range with a grounded-base oscillator. Since the f-m band covers approximately 20 mc, a 25-mc i-f frequency was selected as a compromise between i-f gain and primary-image rejection.

Feedback capacitor C_1 causes transistor Q_1 to operate as a two-terminal negative-resistance oscillator. The grounded-base configuration provides stability and uniform oscillator performance. Variable inductance L_1 is the tunable element, while C_2 is used only to align the oscillator to the tuning dial. Attempts to use C_2 as the tuning element will result in an undesirable shift in the tuning of i-f transformer primary L_2.

The combination of C_4 and L_4 is series tuned to the mean oscillator frequency to assist in reducing the voltage across L_2. Since, as far as the transistor is concerned, L_2 and C_3 could just as



Bottom and top views of complete transistorized f-m tuner show component layout and integral power source

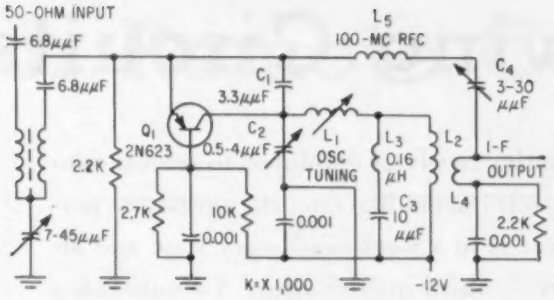
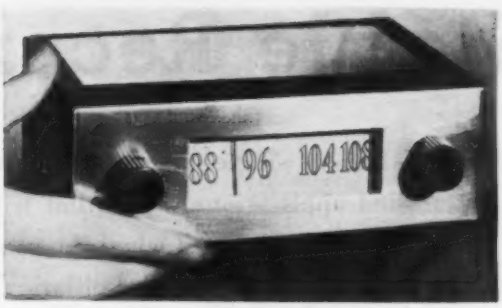


FIG. 1—Oscillator is tuned with brass-powdered iron hybrid tuning slug in L_1. Choke L_5 prevents C_4 from interacting with input



Tuner covers entire f-m broadcast band by varying single tunable element in local oscillator

Four Transistors

well comprise the oscillator tank circuit, admittance neutralization from secondary L_4 to the base of Q_1 is necessary. Loading L_5 at the oscillator frequency is only a partial solution as the mismatch required to prevent oscillation at the intermediate frequency also reduces the circuit gain to an impractical figure.

The neutralization shown is conventional except for r-f choke L_5, which prevents neutralizing capacitor C_4 from interacting with the input of the mixer Q_1 at the signal frequency. Since L_5 should be inductive at 25 mc, it is necessary to increase C_4 to keep a net capacitive reactance of the correct magnitude at the intermediate frequency.

At the oscillator frequency, the neutralization network is effectively not present because L_5 is a low impedance and there is little signal transfer from the transformer secondary back to the transistor input.

Conversion power gain of 10 to 12 db is obtained by operating Q_1 at 1-ma emitter current. Increasing this emitter current will increase the gain slightly, but neutralization and oscillator injection problems are increased.

In the preliminary design shown, the oscillator voltage appearing at the antenna terminals is marginal as far as the FCC regulations are concerned. Slight changes in layout and circuitry should reduce this voltage to an acceptable value.

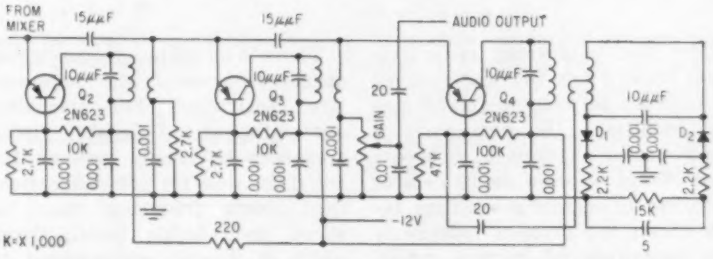


FIG. 2—Three-stage i-f amplifier has total gain of 60 db plus audio gain

I-F Amplifier

The 25-mc i-f amplifer has three stages of 20-db gain per stage. The common-base configuration employed in Fig. 2 is quite stable and affords good interchangeability, even with fixed values of neutralizing capacitor C_4 (Fig. 1).

The transistors are operated at 1-ma emitter current. Increasing this value to 2 ma will raise the gain approximately 1 db per stage, to the deteriment of interchangeability with fixed neutralization.

The last i-f stage also operates as an audio-frequency emitter follower in a conventional reflex circuit that provides sufficient audio power gain and a low output impedance.

Design of the transistor-driven ratio detector, as compared to electron-tube versions, is modified by the fact that the loaded Q of the transformer primary is no longer determined solely by the transformer diode loading. In particular, the shunting effect of the output resistance of transistor Q_4 must also be considered. However, by adjusting the transformer's tertiary turns, it is possible to obtain a match between the collector output resistance and the transformed diode load.

The complete tuner has a sensitivity of 3 μv for a 10 db $(s+n)/n$ ratio with a signal deviation of 22 kc. Audio output is 10 mv for 1.5-μv input and 25-mv output for 10-μv input. The i-f amplifier has a 3-db bandwidth of 500 kc and detector peak separation is 700 kc.

The author acknowledges the help and suggestions of Roger Webster and Floyd Ducote.

Stable Receiving Circuits

Analysis of single-stage superregenerative receivers employed in remote-controlled applications shows that with self-quenching circuits, optimum performance is obtained when the receiver is in a weak oscillatory state and an incoming signal causes oscillation every third quench cycle. Vacuum-tubes exhibit low sensitivity to impulse noise, wide dynamic range and high gain

By **S. J. NESHYBA** Convair Division, General Dynamics Corp., Fort Worth, Texas

F. E. BROOKS, JR. Electrical Engineering Research Laboratory, University of Texas, Austin, Texas

MANY REMOTE-CONTROL radio systems require only that the receiver distinguish between on and off signal conditions. In such cases a fundamental requirement is a current change between the two states sufficient to operate a sensitive relay. Since the primary concern is the magnitude of current difference, linearity is not a criterion. This article will analyze superregenerative detection of low-level signals centered around 30 mc.

Functional Requirements

A suitable receiver for model-aircraft or other remote-control applications should be light in weight, have low power requirements and be simple to adjust and maintain. It should have adequate sensitivity for weak signals without blocking on strong signals, be stable and reliable in operation and have maximum difference in plate current between on and off signal conditions.

In the ordinary superregenerator, oscillations at resonance are made intermittent by applying a quench voltage to one of the tube electrodes. The circuit is essentially a parallel-resonant tank shunted by the negative conductance of the tube. During each quenching cycle the r-f oscillations build up from the level either of signal voltage or of random noise.

There is an optimum quench frequency for greatest superregenerative sensitivity[1]. For sinsuoidal quench the ratio of signal to quench frequency is usually between 100 and 1,000 and for communications the quench frequency must be above the audible limit. Bandwidth is directly proportional to quench frequency and long quench cycles are therefore required for high selectivity[2].

The upper limit to quench frequency is determined by the damping of the oscillator circuit and must be low enough to permit the previous quench to decay to noise level. Exceeding this limit causes the oscillations to build up from the still decaying quench. Under this condition the receiver is insensitive to any signal and is said to be in a coherent state.

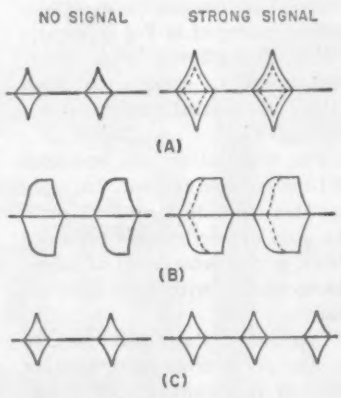


FIG. 1—Operating conditions of common superregenerator designs. First two are separately quenched in linear (A) and logarithmic (B) modes. Self-quenched, linear-mode condition is shown at (C)

The quench-voltage waveform also affects receiver characteristics. A relatively slow rate of change from positive to negative tube conductance produces a longer reception period, resulting in higher selectivity and sensitivity than sinusoidal quench[3,4].

Modes of Operation

If a separate source supplies the quench voltage, the receiver will operate in the linear mode. Then the maximum r-f oscillation amplitude during each quench cycle depends linearly on signal strength as shown in Fig. 1A. Thus the receiver distinguishes between off and on by a plate-current increase with signal.

The separately quenched receiver may also operate in the logarithmic mode if the part of the quench cycle during negative tube conductance is long enough for oscillations to reach limiting amplitude. With strong signals they reach this point earlier in the quench cycle, thus producing an increase in plate current, as shown in Fig. 1B.

If the oscillator supplies its own

for Remote Control

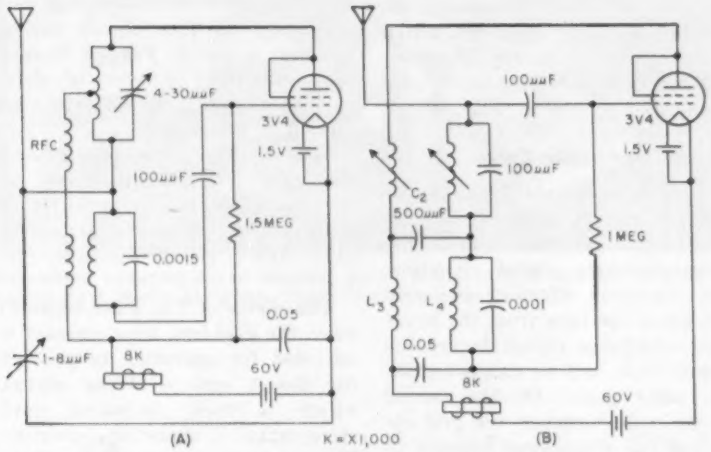


FIG. 2—Typical single-stage superregenerators are the Miller (A) and Franklin (B). Both circuits provide a large decrease in plate current with signal.

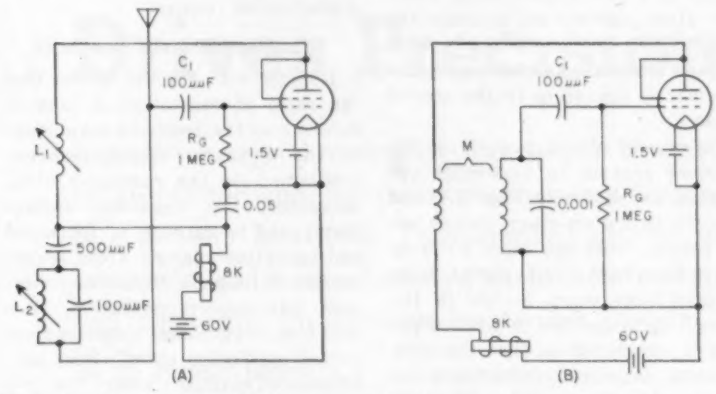


FIG. 3—Franklin circuit simplified to show equivalent signal-frequency (A) and quench-frequency (B) oscillators. Receiver acts as a relaxation oscillator

quenching voltage, each successive peak will be of equal amplitude regardless of signal strength. Here the quench frequency increases with signal, as shown in Fig. 1C. Similarly the plate current increases with signal because of more pulses in a given time.

Typical Circuits

The single-stage superregenerative receivers for remote control are self-quenching. Two common circuit types differ from conventional circuits in the large decrease in average plate current with signals above the sensitivity threshold.

One type of receiver employs a miniature gas triode, whose current in the absence of signal is used to close a relay. This type has high sensitivity, but its operating costs are higher than in receivers using vacuum tubes. Interelectrode capacitances vary over the 10-hour life expectancy of the gas tube requiring continuous circuit readjustment.

The vacuum-tube family of receivers to be analyzed here is typified by the two circuits of Fig. 2. The Miller circuit is well known in the model-control field for its reliability. The Franklin circuit is more flexible, however, since the quench-oscillator components are at r-f potential and feedback adjustments are more easily made.

Multiple Oscillation Modes

The Franklin circuit may be analyzed as an oscillator operating in three modes. First, the receiver oscillates at 27 mc. The circuit shown in Fig. 3A reveals this is a modified Hartley oscillator with interelectrode capacitances tuned by L_3. The receiver also oscillates at a low quench frequency of about 25 kc. The circuit in this case is an ordinary plate-feedback oscillator, as shown in Fig. 3B.

The wide separation between the signal and quench frequencies allows separation of these circuits by the selection of L and C components presenting required reactances at one frequency and negli-

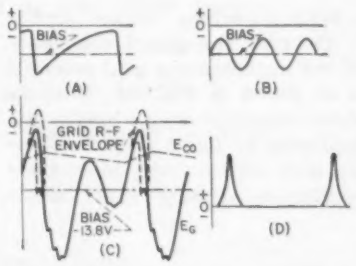


FIG. 4—Voltage conditions in Miller circuit show quench component (A), grid-leak component (B), composite waveform at grid (C) and r-f output pulses (D) in response to moderate signal levels

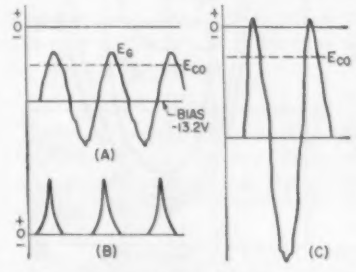


FIG. 5—On strong signals, grid waveform of Miller circuit is as at (A), output as at (B). Weak signal produces grid-voltage waveform of (C) and no r-f output

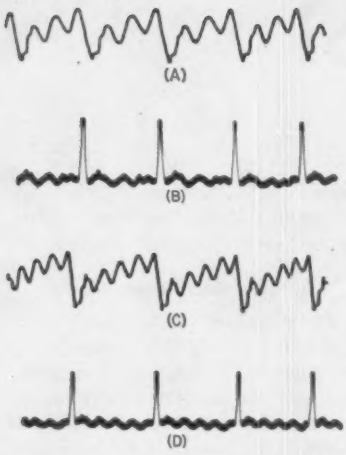


FIG. 6—Franklin circuit grid-voltage waveforms in third mode (A) and fifth mode (C). Pulsed r-f outputs in same modes are shown in curves (B) and (D)

gible reactance at the other. The receiver thirdly acts as a relaxation oscillator at or below the quench frequency. This is produced by the large time constant in the grid-leak bias circuit blocking the oscillation at signal frequency.

Component Functions

With quenching voltage applied to the grid, the quench component of the instantaneous grid potential is as shown in Fig. 4A. With no signal input the circuit breaks into oscillation at signal frequency during each quench cycle. Since these oscillations develop from innate noise, their amplitude is insufficient to cause grid-current flow and no relaxation pulses occur.

A signal above threshold causes r-f bursts large enough that grid current flows during part of the quench cycle, with relaxation oscillation resulting from the action of the grid-leak elements. This component of the instantaneous grid potential is shown in Fig. 4B.

Composite Curve

The composite grid voltage curve shown in Fig. 4C is the sum of the quench and grid-leak components under moderate signal reception. The relaxation effect of the grid leak keeps the tube from the negative-conductance region during one quench cycle and no signal oscillation takes place. On the second quench cycle, however, the grid capacitor has discharged enough to allow an oscillation burst and accompanying grid-current flow. The result is a sharp decrease in average plate current to operate the relay. When oscillatory bursts occur only on alternate quench cycles, the receiver is operating in the second mode,

On receipt of a strong signal the receiver reverts to first-mode operation as shown in Fig. 5A and 5B. Operation on every quench cycle results from the rapid build-up of r-f from high initial signal. Grid current flows much earlier in the quench cycle and the oscillation period is shortened so that the tube exhibits negative conductance on each cycle. Since r-f oscillations build up from random noise under weak-signal conditions, Fig. 5C represents noise amplification only, without the spectrum characteristics of modulated oscillations.

Franklin Sensitivity

A further increase in grid-leak time constant of the Franklin circuit will cause oscillation only during every third or higher quench cycle, as shown in Fig. 6. In each case sensitivity in terms of plate-current change between signal on and off is increased.

Selectivity, on the other hand, decreases as oscillation bursts occur less frequently. The effect of higher-order modes on receiver bandwidth is clearly shown in Fig. 7.

The curves of Fig. 8 are obtained when the grid-leak time constant is adjusted for operation in each of the modes with a strong signal, which is then decreased until steady-state operation occurs. These curves indicate that the initial jump in plate current occurs with lower signal strengths for higher-order modes.

Superregenerative Feedback

Reference to Fig. 3A shows that the ratio of reactances L_1 and L_2 determines the feedback magnitude in the Franklin signal-frequency oscillator. As the reactance of L_1 decreases, the feedback voltage from grid to cathode is increased and operation changes from regeneration through a region of coherence into superregeneration, at a grid bias slightly less negative than quench-oscillation cutoff. Best performance obtains when the r-f oscillator is in a weak oscillatory state and optimum change in plate current occurs.

Inductance L_1 in the Franklin receiver is commonly referred to as the sensitivity control. With grid-leak C_1R_G fixed and L_2 resonated to the signal frequency, as the ratio of L_1 to L_2 decreases operation passes from every quench cycle to every second and finally to every third cycle.

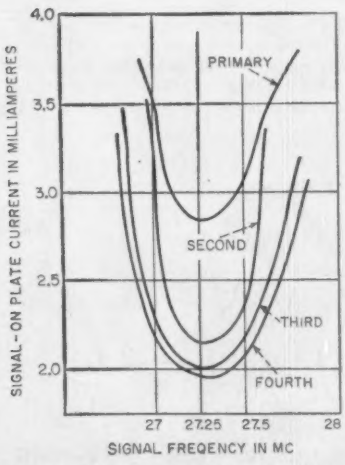


FIG. 7—Frequency response of Franklin circuit operating in various modes

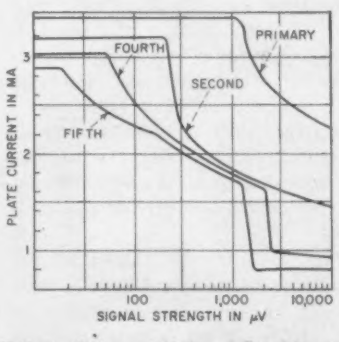


FIG. 8—Plate sensitivity of Franklin circuit operating in various modes

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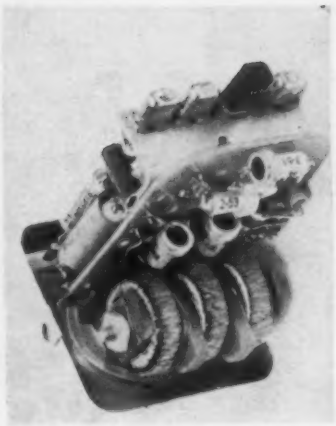
Regenerative frequency divider assembly shown in operation driving the precision clock above it. Device has proven highly reliable over long period



Interior view of typical divider unit shows modular construction

Regenerative Divider Drives Precision Clock

A precision crystal-controlled 1-mc source is converted to 1-kc clock power by two-factor and five-factor regenerative frequency dividers, cascaded to give division by 1,000. Transistorized divider units employ feedback of lower sideband from a balanced modulator to synthesize necessary modulation frequency for division by desired integer

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THE FREQUENCY DIVIDER chains for operating a precision clock must be reliable. The regenerative type of frequency divider, with its pure output signal, has long been recognized for this characteristic. Unlike the common relaxation types, the regenerative divider will not produce an error in the division ratio for which it has been designed, nor will it provide any output in the absence of an exciting signal. The use of junction transistors in this application results in a device with a high degree of reliability and low power consumption.

The block diagram in Fig. 1 shows an overall layout of a crystal-controlled clock. The frequency-divider chain is required to convert the 1-mc signal generated by the frequency standard to 1 kc for operation of the clock mechanism.

Operating Principles

The regenerative type of frequency divider is in reality a pseudo-oscillator in that its synchronism can be attributed mainly to the action of intermodulatory feedback. The manner in which this occurs may be described best by first considering an elementary frequency converter as shown in Fig. 2A. If the modulator is balanced and the modulating function is linear, its output signal will contain only the sum and difference of the two input signals.

$$\omega_o = \omega_c \pm \omega_m \qquad (1)$$

Since it is desired to divide the input signal frequency by some integer n, the modulating frequency in Eq. 1 must be

$$\omega_m = \frac{\omega_c}{n}(n-1) \qquad (2)$$

Thus, to form a divider, it is necessary to synthesize ω_m. To do

FIG. 1—Block diagram of crystal-controlled clock

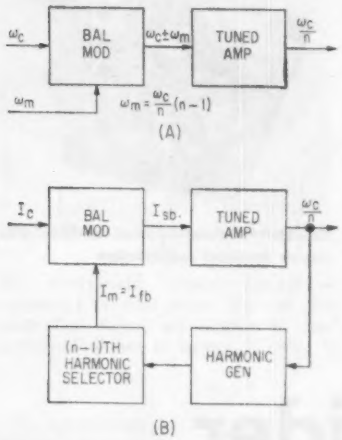

FIG. 2—Simplified block diagram shows use of feedback in an elementary frequency converter (A); in (B), ω_m is synthesized by feedback of output through a harmonic generator

this, the lower sideband is selected as the output signal, multiplied by $(n\text{-}1)$ then used in place of ω_m. Such a divider is shown in Fig. 2B. To have regeneration around the loop in Fig. 2B, I_{fb} must be greater than I_m. If the modulator efficiency is k_m, the amplitude of the lower sideband may be expressed as

$$I_{sb} = k_m I_c I_m \qquad (3)$$

The amplitude of the synthetic modulating signal I_{fb} is that given by Eq. 3 multiplied by the gain transfer factors G_a and G_h of the tuned amplifier and harmonic generator, respectively. When the feedback loop is closed, I_m becomes I_{fb} and $k_m I_c G_a G_h \geqq 1$, to sustain oscillation. The required loop gain is achieved preferably in the lower sideband amplifier, hence the gain of this amplifier must then be

$$G_a \geqq \frac{1}{k_m G_h I_c} \qquad (4)$$

To insure automatic starting, it is necessary to use a much higher gain in practice than is indicated by Eq. 4. This is because k_m and G_h are initially infinitesmal, so that for the divider to start, circuit perturbations caused by noise, switching transients, etc., must be relied upon to initiate a signal within the feedback loop. Once a signal is established, it will build up rapidly until limited by the modulator, or by the bottoming of a transistor.

If the divisor n is 2, the harmonic generator is not required and a much simplified type of divider results. In practice, this type may be made to divide by any low value of even integer if a nonlinear modulating function is relied upon to generate the necessary sidebands.

In the simplified form of divider, selfoscillation may occur if the loop gain is high and the modulator becomes unbalanced. If k_l represents the leak factor caused by an unbalanced modulator, the criterion of unconditional stability of the system is that $G_a < 1/k_l$. The presence of a harmonic generator within the loop effectively suppresses the fundamental signal from entering the modulator, hence greatly reduces the susceptibility to a free-running condition.

Decade Dividers

From the foregoing theoretical considerations, it would seem logical to design a single decade divider unit. Practical experimentation has indicated, however, that it is simpler and more reliable to perform the decade division in two stages by cascading a two-factor and a five-factor divider.

The schematic of a typical two-factor divider is shown in Fig. 3A. The lower sideband output from a series type Cowan modulator is selected by a common-base transistor amplifier, Q_1. Part of the output signal from this amplifier is fed back to the modulator, and the balance is used to drive the buffer-amplifier Q_2.

Figure 3B is the circuit of a

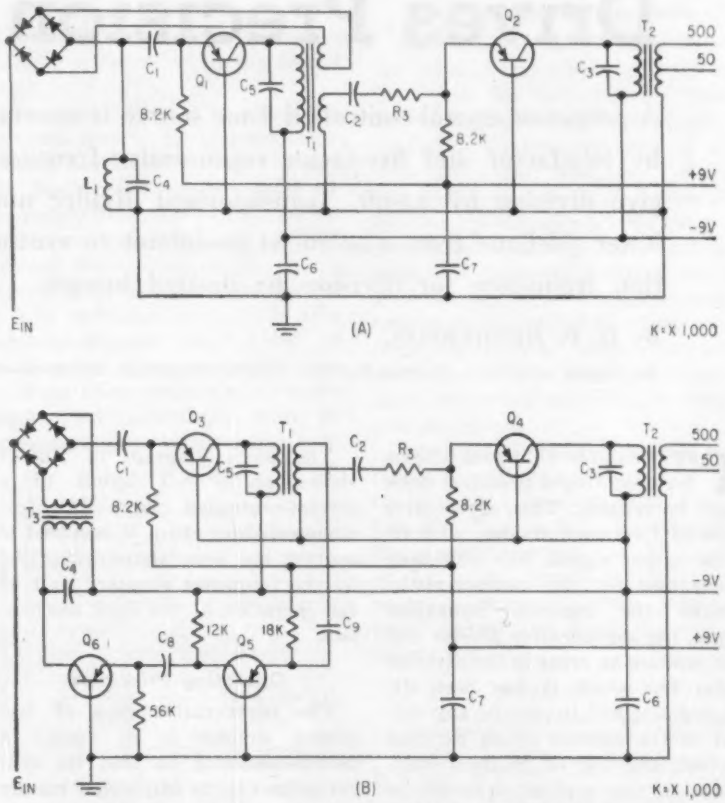

FIG. 3—Schematic diagram of two-factor divider (A) and five-factor divider (B). Component values for dividers in chain for division by 1,000 are in Table I

typical five-factor divider. A series modulator again supplies the required sidebands for selection by the tuned common-base amplifier stage Q_a. A portion of the output from this system is passed on to the buffer-amplifier Q_b. The remaining portion is amplified by an R-C-coupled transistor amplifier Q_c to provide the required voltage drive for the harmonic generator transistor Q_d. The $(n\text{-}1)$th harmonic is then selected from the resulting spectrum by tuning the primary of the modulator matching transformer.

Divider Chain

The frequency-divider chain employs six divider units of the type described above. This accomplishes the required overall division of 1,000 and also supplies the intermediate output frequencies for external distribution.

Each unit in the chain, with the exception of the final stage, employs a buffer-amplifier with a 500-ohm output impedance to provide the exciting signal to the succeeding divider stage. A 50-ohm impedance tap is also provided. The two-factor divider is used in the first stage of the chain because it does not contain a harmonic generator. Thus the input frequency is halved before amplification is required. This is then followed by a five-factor divider to complete the first decade division. The order is then repeated until the necessary overall ratio is achieved.

Table I—Frequency Divider Components

		Operating Frequency					
		2-Factor			5-Factor		
Component	Units	1–0.5 mc	100–50 kc	10–5 kc	0.5–0.1 mc	50–10 kc	5–1 kc
C_1, C_2	μf	0.02	0.1	1	0.05	0.5	5
C_3	μf	0.00068	0.004	0.04	0.0033	0.033	0.33
C_4	μf	0.0033	0.033	.....	0.0004	0.0027	0.027
C_5	μf	0.0002	0.002	0.01	0.0023	0.005	0.05
C_6, C_7	μf	0.1	1	10	.....	.....	.....
C_8, C_9	μf	.....	.....	.....	0.01	0.1	1
R_3	ohms	adjusted to give desired output (approx 220 ohms)					
L_1	mh	0.03	.....	0.3	.....	.....	.....
T_1 pri	mh	0.4	5	100	2	5	500
T_1 turns ratio:							
pri: mod		8:1	8:1	10:1	15:1	20:1	20:1
pri: buffer		30:1	30:1	40:1	50:1	50:1	50:1
T_2 pri	mh	0.15	2.5	25	0.75	7.5	75
T_2 turns ratio		8:1	8:1	8:1	8:1	8:1	8:1
Min Q of T_1, T_2 at divider freq		100	50	30	75	40	20
T_3 pri L	mh	.....	.....	.....	0.6	6	60
T_3 turns ratio		.....	.....	.....	10:1	10:1	10:1
Min Q of T_3		.....	.....	.....	150	75	50
T_3 pri resonant freq		.....	.....	.....	400 kc	40 kc	4 kc
Min transistor $f_{\alpha co}$		1	500	100	1	500	100
Transistor type used		2N123	2N123	2N123	2N123	302	302

Each unit is built into a turret type of plug-in assembly. The complete divider, which comprises six of these units and a power supply, is constructed on a standard rack panel. Total power consumption of the device is less than one-half watt.

Performance

Figure 4 illustrates typical behavior of the two types of divider units. Signal limiting occurs rapidly as indicated by the flattening of the curves. The dashed portion represents an uncertainty region over which the divider is just on the threshold of operation. The normal operating input signal from the preceding units is about 1v, hence a large safety margin exists above the threshold value.

Although no temperature compensation is provided, the device has been checked over the possible temperature range of indoor operation (0 C to +50 C) and found to operate satisfactorily.

The device has been in continuous operation for about three years with the exception of about one day each year for transistor checks. In spite of a large I_{co} increase in several transistors, no deterioration in performance has been noted.

The author is grateful to the Defense Research Board for permission to publish this article, and to N. F. Moody for advice in development. Thanks are due also to K. Bedal for the construction and testing of the device.

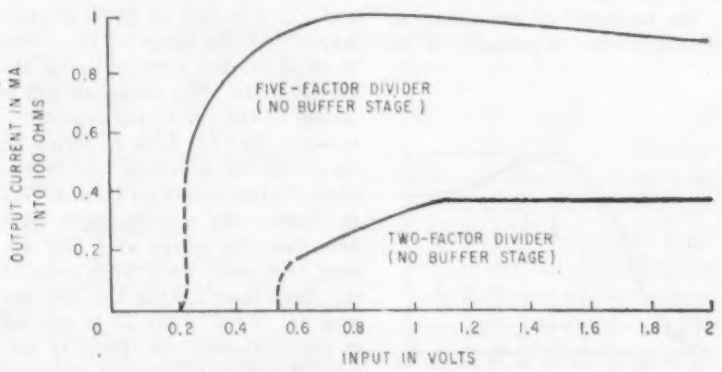

FIG. 4—Performance characteristics of divider units. Input signal from preceding stages is about 1 v, resulting in operation above ambiguous region (dotted)

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Light Modulator Records

Light modulation using an ultrasonic cell achieves resolution and dynamic ranges previously unattainable. For applications in video recording and radar strip-mapping, resolution of the device is limited only by the optical system and photographic material. Additional data can be displayed in color

By **LEO LEVI**, Laboratory Manager, Fairchild Camera and Instrument Corp., Defense Production Division, Syosset, N. Y.

LIGHT MODULATION is not a new technique. The development of wirephotos and soundtracks on movie films have considerably advanced this technique. With the advent of television and radar however, problems of new proportions have resulted. Whereas earlier work involved light modulation at audio frequencies, it now is necessary to convert signals in the megacycle range into visible form.

One successful light modulation device is the cathode ray tube. Because of the relative facility of scanning an electron beam, the crt is simple and flexible. Unfortunately, a crt display suffers from limited resolution and low dynamic range. Low resolution is caused by limitations in focusing the electron beam. In practice it is not possible to obtain much more than 1,000 elements across a tube diameter with any appreciable contrast.

The limitation in dynamic range is a result of the halation effect which accompanies a crt display. Dynamic range is defined as the ratio of the maximum signal displayed to the minimum signal observable. If low light intensity is measured on a spot of the crt display, it cannot be learned for certain if there actually is a low intensity beam impinging on this spot or if the halation effects from an adjacent bright spot are illuminating it. In practice the dynamic range of the cathode ray tube is limited to approximately 15 to 1.

Ultrasonic Cell

Ultrasonic light modulation overcomes the basic crt deficiencies outlined above. Its operation is based on the diffraction of light at ultrasonic wave fronts. The heart of the system is the ultrasonic cell, which consists essentially of a liquid medium in contact with a piezoelectric transducer. This transducer has the property of expanding or contracting when a potential is applied across it. When an alternating potential is applied, it vibrates, sending pressure waves down the column of liquid in contact with it. These pressure waves produce periodic variations in the refractive index of the liquid.

Diffraction Grating

The portions of the incident light wave which pass through pressure peaks are retarded and those passing through the pressure troughs are advanced in phase. As a result, a plane wave front entering the ultrasonic cell leaves it as a corrugated wave front producing a diffraction grating effect.

The operation of the system is illustrated by the optical schematic shown in Fig. 1. A slit in diaphragm D_1 is illuminated by the source S through condensing lens L_1. An image of the slit is formed on an opaque bar at D_2 by lenses L_2 and L_3. The bar at D_2 is slightly larger than the image of D_1 so that it stops all the light entering the system at D_1. The ultrasonic cell is placed in the collimated region between L_2 and L_3. Lens L_4 forms an image of the ultrasonic cell in the plane F after reflection from mirror P. Under the circumstances just described, the image at F will appear completely dark since none of the light illuminating the cell can pass D_2. When a signal is applied to the ultrasonic cell, light is diffracted around the stop D_2, as indicated by the dotted line. Light now passes D_2 and as a result the image

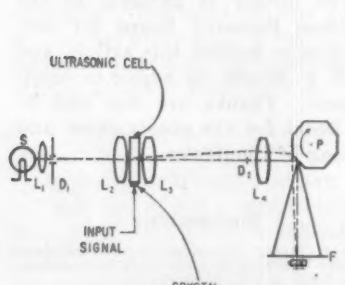


FIG. 1—Ultrasonic cell produces intensity-modulated image at surface F

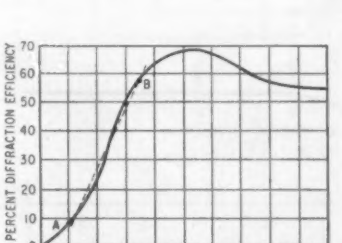
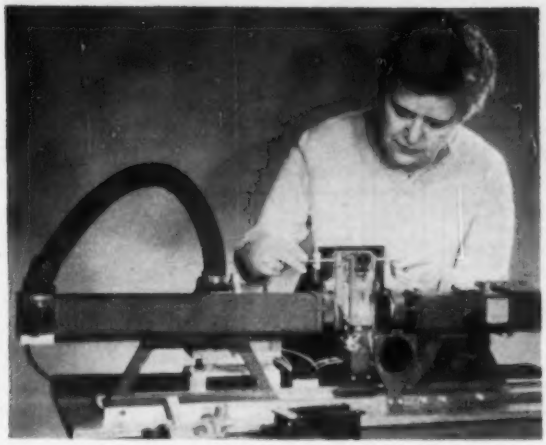
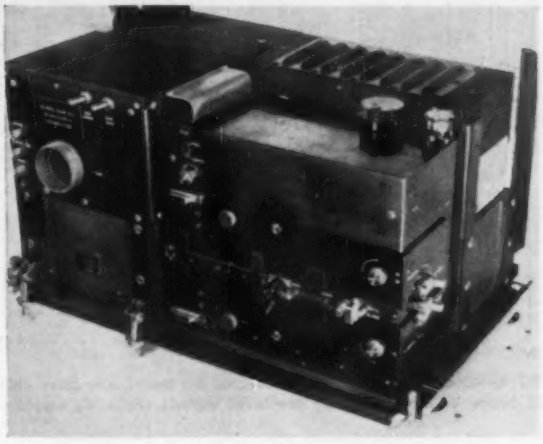


FIG. 2—Diffraction efficency plotted as a function of input signal amplitude

Airborne Radar Displays





THE FRONT COVER—Ultrasonic cell shown being adjusted at left is the heart of radar airborne strip-map recorder at right. High resolution, dynamic range, and linearity as well as its ability to vary the color of the recorded image make recorder versatile and flexible

at surface F becomes bright.

If a short burst of carrier wave is applied to the transducer, a train of pressure waves travels down the ultrasonic cell. At F this appears as a bright spot traveling the length of the cell image with the velocity of sound in the cell medium, as indicated by the arrow in the cell image at F. To record this spot of light, either a short exposure may be used or the spot may be made to stand still by rotating the reflector P. A rotation of the reflector in the sense indicated in the diagram makes the cell image move in the direction indicated by the arrow at F. If the velocity of image motion is equal and opposite to the velocity of the pulse inside the cell, the pulse has no net velocity with respect to the surface F. This scanning action makes the total time interval recorded during one sweep independent of the cell length.

Resolution

With the ultrasonic light modulator it is possible to obtain tens of thousands of resolution elements in a single scan line. In aerial photography, the only limitations are photographic, specifically, the resolution of the photographic material and the optical components.

Resolution in time is limited by the bandwidth. However, information bandwidths close to 20 mc have been obtained with this device. Furthermore, there is no halation effect analogous to that in the crt. As a result, dynamic ranges of several hundred to one have been obtained in field models, and in laboratory models considerably higher ratios are realizable.

The linearity of the ultrasonic light modulator is shown in Fig. 2. The diffraction efficiency is plotted as a function of input voltage for an ultrasonic light modulator arrangement used in video recording. Diffraction efficiency is defined as that percentage of the light entering the system at D_1 (Fig. 1) which goes into the formation of the final image. It can be seen from Fig. 2 that

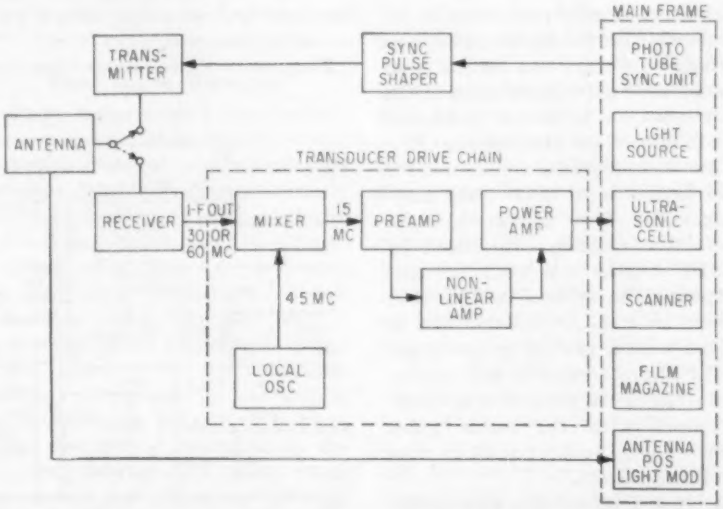


FIG. 3—Block diagram of a typical radar strip map recorder using the ultrasonic cell. The antenna position light modulator records antenna position on the film

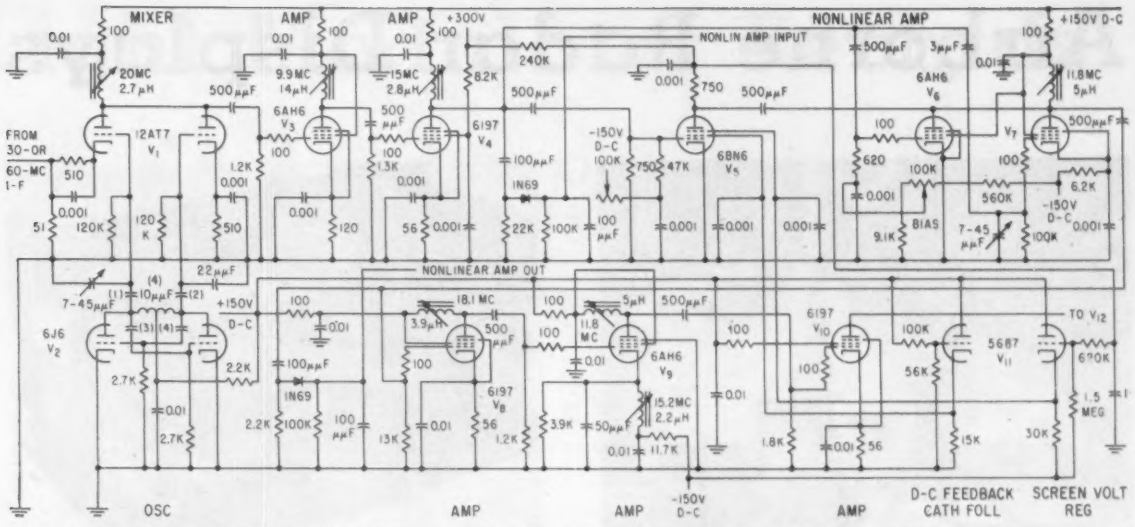


FIG. 4—Circuit schematic of a portion of the transducer drive chain. Linearity correction is made by adjustment of the gains of V_5 and V_6. Stage V_5 amplifies only low-level signals while V_6 amplifies only high-level inputs

when 125 v rms is applied to the transducer, the diffraction efficiency approaches 70 percent. The portion of the curve between points *A* and *B*, corresponding to 9 and 58-percent diffraction efficiency, respectively, is linear within 2 percent.

Video Recording

The simplest application of the ultrasonic light modulator is in video recording. If in Fig. 1, photographic strip film is placed in the plane of *F* and driven so that during the period of a single scan the film moves the width of a single scan line, the film is filled with transverse scan lines, density modulated in accordance with the input signal amplitude. To start the second scan immediately after completion of the first scan, a mirrored polygonal prism is used for the reflector *P*.

Another recording application for this device, is in radar strip mapping. The first ultrasonic light modulator recorder, sponsored by WADC (ARL) was built for that purpose. The system used is that shown in Fig. 1, but the film is driven with a velocity proportional to the aircraft velocity and successive scans of the reflector *P* are synchronized with the radar pulse transmission, so that a strip map recording results.

A block diagram of a representative system is shown in Fig. 3. A radar recorder which is to work with several radar systems is illustrated. The radar i-f, either 30 mc or 60 mc, is mixed with a 45-mc local oscillator. The resulting 15-mc carrier is amplified further, linearized to compensate for nonlinearities in the ultrasonic diffraction effect and the photographic emulsion and then applied to the ultrasonic cell located on the main frame.

An antenna position light modulator, which records a density-modulated track at the edge of the film in accordance with antenna position, is required because the radar sweeps are recorded next to each other in strip-map fashion, though they are derived either from a ppi or sector-scan radar.

Because of its relatively high inertia, it is more convenient to permit the scanner to trigger the radar transmitter than to have the radar transmitter control the scanner. A simple method uses light from an illuminated slit, reflected from the scanner and picked up by a phototube. With this method trigger accuracies better than 5 millimicrosec have been obtained.

Transducer Drive Chain

Schematics of the transducer drive chain are shown in Figs. 4 and 5. Tube V_1 is the mixer, V_2 the local oscillator, V_3 and V_4 the preamplifier. The nonlinear amplifier comprises V_5, V_6 and V_7. Tube V_5 amplifies only low-level signals and V_6 only high-level signals so that

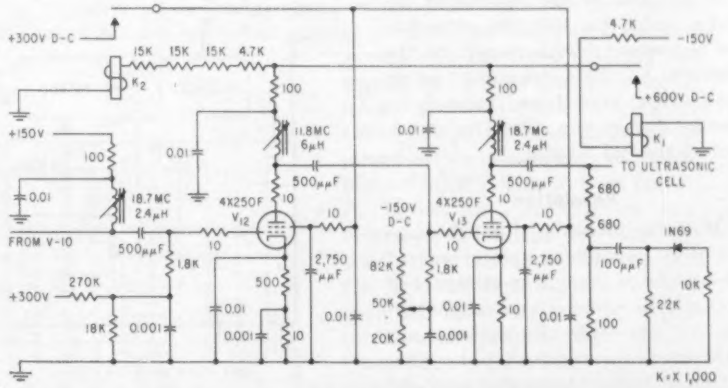


FIG. 5—Schematic of final power stages of the transducer drive chain. Relays K_1 and K_2 protect the circuit in case of bias or plate supply failure

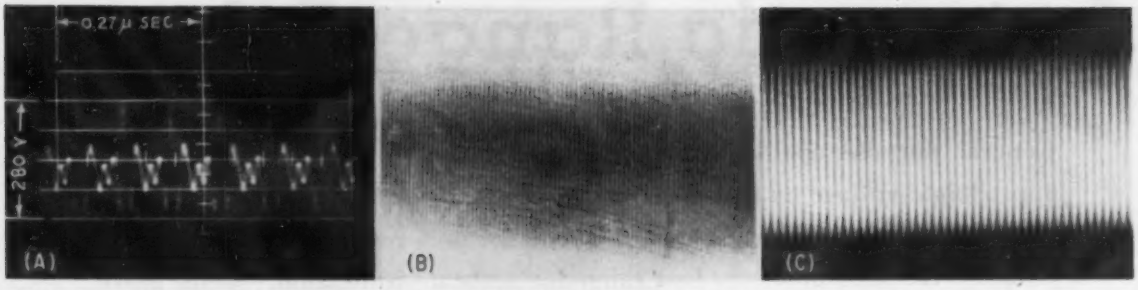


FIG. 6—Recordings attained with a high resolution radar display unit. Input signal (A) at 11 mc produced recording (B). Each band corresponds to 25 ft of range. Higher contrast is achieved with a cleaner test signal. Photo (C) represents recordings of 0.1-μsec pulse train separated by gaps of 0.1-μsec duration

good linearity may be obtained by adjusting the gains and operating points of these two stages. Stages V_9 through V_{10} constitute the power amplifier stage.

Special provisions are made in this amplifier to shape its frequency response to compensate for the resonance characteristics of the ultrasonic transducer.

The problem of testing the ultrasonic light modulator recorders on the ground requires a special test signal generator. For this purpose an optical flying-spot scanner was built. In this unit the image of a pinhole is scanned across a transparency carrying a test pattern. The transmitted light, intensity modulated by the test pattern, falls on the cathode of a multiplier phototube. The output of the phototube, suitably amplified, is then applied to the radar recorder.

A ppi scan can be obtained either by rotating the film behind a stationary slit or by rotating an image of the scan line using an optical inversion system. Both methods are employed.

Radar Display

A radar display unit to work in conjunction with a high-resolution radar has been recently completed. This work was supported by the Evans Signal Laboratories. The unit displays a B-scope scan on a 16-in. square ground-glass screen. The frame scan rate is 100 per sec and the pulse repetition rate 10,000 pps. Since the frame scan is unidirectional, a second rotating mirror prism is used for this scan. The display unit resolves two objects separated by 25 ft in range. Fig. 6A shows an 11-mc signal applied

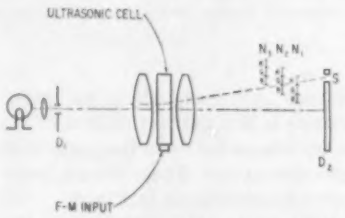


FIG. 7—Diagram illustrates how diffraction grating effect of ultrasonic cell makes color modulation possible

to the display unit and Fig. 6B shows the resulting display. Each light and dark band corresponds to 25 ft. in range. The input signal is shown only to account for the low contrast in the displayed signal. Difficulty in suppressing the carrier between signal pulses because of the relatively high modulation frequency accounts for the low contrast. At lower frequencies, where a better test signal was available, higher contrast was obtained as shown in Fig. 6C which represents a series of 0.1-μsec pulses separated by 0.1-μsec gaps.

Slant Range Distortion

Radar maps points with a separation proportional to the difference between their distances from the antenna and not proportional to their separation in space. Consequently, recordings taken at high altitudes suffer from what is known as slant range distortion. In conventional radar indicators this is compensated for by using a hyperbolic sweep. For the ultrasonic radar recorder, an optical method of slant range correction is used. This method is geometrically accurate and lends itself readily to adjustment for changing aircraft altitude. The method consists of converting the strip image into a circular sector by rotation around the zero slant range point. If a strip is selected from this sector at a distance from the center proportional to the aircraft altitude, a corrected ground range display is obtained.

Color Modulation

Ultrasonic light modulation lends itself readily to color modulation of light. As pointed out earlier, the ultrasonic cell is essentially a diffraction grating which separates the incident light into its spectral components. The image of a narrow slit at D_1 (Fig. 1) appears drawn out to a full spectrum in each diffraction image at D_2. If one color is now selected from the spectrum, the cell image appears in that color.

The spectrum appearing under N_1 in Fig. 7 is shown in the position it assumes with frequency N_1 applied to the transducer. In that position, the red portion of the spectrum is passed by slit S. When the frequency is increased to N_2, the spectrum moves away from the optical axis, so that only the green light passes. A further increase in frequency results in passing of only blue light. Thus, the color of the cell image is varied by frequency-modulating the carrier signal applied to the cell, just as the brightness of the cell image is varied by amplitude modulations. Thus continuous change in hue is possible.

This effectively adds another dimension to the recording which may be used to record additional information contained in the input signal. For example, a combined radar display may be devised featuring elevation data in color.

Automatic Range Selector

General purpose test instrument eliminates need for manual selection of appropriate voltage or resistance range before measurement. Equipment features automatic selection of a-c, d-c voltage and resistance range and d-c polarity. Instrument selects best range for accurate indication. Meter movement is disabled during automatic range selection to prevent overload damage

By **MAX HOBERMAN** Chief Engineer, Bergen Laboratories, Clifton, N. J.

A MULTIRANGE VTVM that uses a simple automatic-selection servo technique for obtaining the most suitable range to read a-c and d-c voltages from 1.5 to 1,500 v and resistances to 100 megohms is described.

Comparator Circuit

Shown in Fig. 1 is the block diagram of the multirange vtvm. The servo, which consists of a thyratron control circuit and stepping switch motor, is connected around the meter and range switch to accomplish automatic range selection.

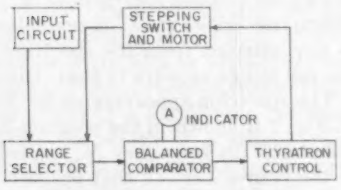


FIG. 1—Block diagram. Simple control circuit and stepping switch servo, looped around meter circuit and range switch, selects a range where the meter is deflected to a satisfactory portion of the scale. Servo replaces manual operation required in the conventional vtvm

Figure 2 contains the complete circuit of the automatic vtvm. Automatic range selection is achieved first by detecting the unbalance that exists in the comparator circuit formed by V_5 and V_6 when a voltage is applied to one grid. The 30,000-ohm plate load resistors are so connected in the circuit of V_5 and V_6 that, in addition to obtaining an unbalance between the cathode voltages when an input voltage is applied to the grid of V_5, an unbalance between the plate voltages also exists. These voltage relationships are shown in Fig. 3.

With zero voltage applied to the grid of V_5 both plates are at potential P_o. With an increasing positive signal applied to the grid of V_5 the plate voltage of V_5 will decrease and V_6 plate voltage will increase toward point C. Meter current ascends along the line AB. When voltage at the V_6 plate reaches C, corresponding to a meter current that is near maximum, thyratron V_7 triggers and resets after each half cycle of a-c plate voltage.

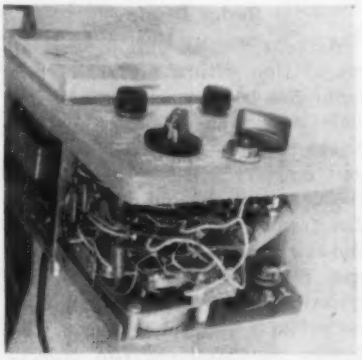
Similarly, if the d-c voltage applied to the grid reduces so that the meter current becomes less along the line BA, the plate voltage of V_5 approaches point D and thyratron V_7 triggers. Control relay K_1 closes when either V_7 or V_8 conducts. This corresponds to a meter current that is between points A and B, a meter deflection greater than about one fourth of full scale and less than full scale.

If both V_7 and V_8 do not conduct, control relay K_1 is inactive. If both V_7 and V_8 conduct the relay also remains inactive. However, this can not occur since it is impossible to obtain a voltage that corresponds to greater than full scale deflection of the meter and simultaneously be less than one quarter scale.

When the control relay is actuated, power is applied to the stepping-switch solenoid L_2. The range selector switch S_1, consisting of decks A, B, C, D, E, F and G, then steps continually. This is done by a self-stepping action obtained through a cam that opens the power to rectifier D_2 immediately after it has stepped one switch position. This permits the bridge to detect whether an unbalance still exists at the new switch position. The switch will continue to step until a range is reached where the voltage at the plate of V_6 is not higher than point C (Fig. 3), and simultaneously the voltage at the plate of V_5 is not higher than point D.

These two conditions can occur only when the meter current is between points A and B of Fig. 3. In actual operation the stepping switch continues to step, sampling each of the multiplier taps of S_1 in sequence and then back to the first tap until a scale is reached that causes neither tube V_5 nor V_6 to conduct. The stepping switch stops at the appropriate scale.

The stepping switch solenoid L_2



Internal view and panel of vtvm that contains standard multimeter scale for reading a-c/d-c voltages and resistance

for Electronic Voltmeter

operates as follows. After relay K_1 closes, corresponding to an off scale condition, and rectified line voltage is applied to the stepping switch solenoid through the closed cam switch, the solenoid pulls in. The stepping switch is rotated momentarily to step one position, simultaneously disconnecting power by opening its cam switch. This resets the solenoid for the next operation. Self-stepping action occurs at a rate of about 6 to 8 steps per second.

Polarity Selection

A small negative voltage applied to the grid of V_4 provides approximately the same plate voltages, P_1 and P_2, as an equal positive voltage applied to the grid of V_3. A +1-v input causes the stepping switch to stop at position 1 of S_{1C} and position 1 of ganged S_{1A} and S_{1B}. A −1-v input causes the stepping switch to stop at position 1 of S_{1C} and position 8 of S_{1A} and S_{1B}. This applies the −1-v signal to the grid of V_4 and provides the same approximate plate voltage conditions at the plates of V_3 and V_4 to keep thyratrons V_5 and V_6 from conducting.

If the stepping switch stops at positions 1 through 7 of S_{1A} and S_{1B} a positive voltage has been applied to the input. If it stops at positions 8 through 14 a negative voltage has been applied to the input. Since these correspond to positions 180 degrees apart on the switch, a shaft projection using a knob with + on one end and − on the other gives a simple polarity indication on the front panel. This polarity reversing action can easily be accomplished on an 8-position rotary stepping switch when only 4 multiplier ranges are to be used. Similarly a 12-position stepping switch will provide 6 input multiplier steps with automatic polarity selection.

Switching Limit—Changing

On the most sensitive scale, voltages must be read between zero and one quarter scale. This is accomplished by changing the voltage divider R_3, R_1 and R_2 so that it requires a voltage as high as P_2 before it conducts instead of voltage D (Fig. 3) as on every other range. This is performed by ganging another switch wafer S_{1F} to the range switch so that on the most sensitive range resistor R_6 is shorted out, requiring a higher voltage at the plate V_3 before V_4 conducts.

Similarly, by ganging S_{1G} to the range switch, thyratron V_5 is disabled on the highest range so that for any voltage in excess of the maximum full scale reading of the meter the switch will not continue to rotate ceaselessly but will stop at the highest range with the needle deflecting off scale. This will indicate the application of a voltage in excess of instrument capability.

A peak-to-peak diode detector rectifies the a-c voltages. Similarly, a battery and precision resistor chain permit the automatic feature to be extended to resistance measurement.

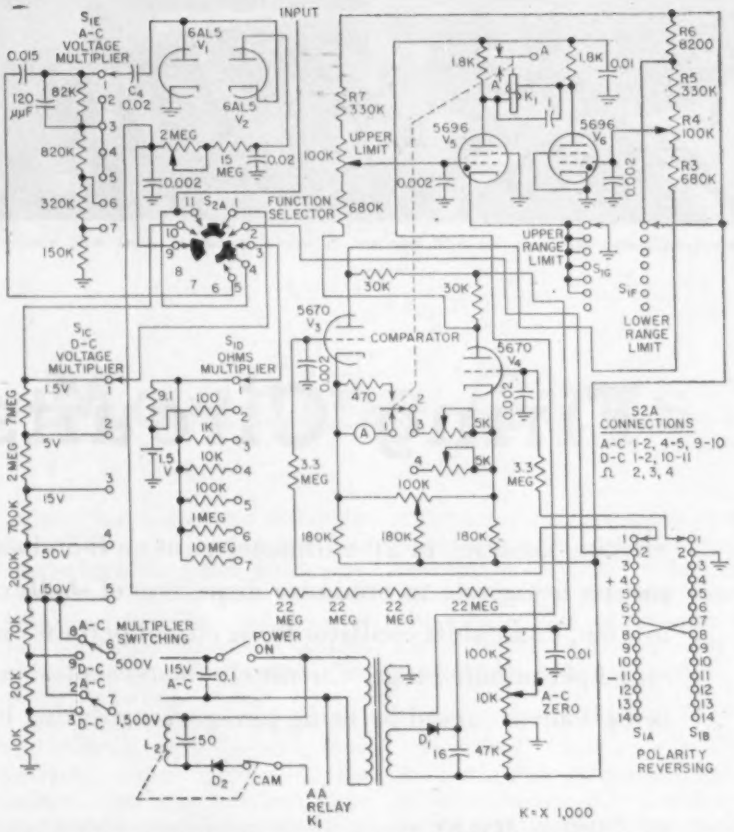


FIG. 2—Schematic of the general purpose tester. Additional set of contacts on control relay K_1 permits isolation of meter during automatic range switching. Power to operate stepping switch motor is obtained directly from line voltage

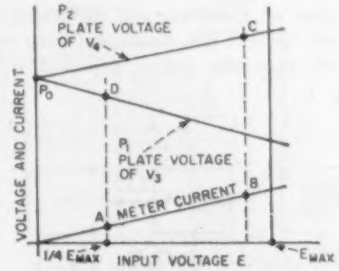


FIG. 3—Graph illustrates relationship of V_3 and V_4 plate voltages to meter current. Servo control operates V_3 range switch and permits it to step and search for the position where the plate voltage of V_4 is not higher than point C and the voltage at the plate of V_3 is not higher than D

Twenty-millimeter M24 gun for B-36 bombers is tested in control room with electronic firing circuit

Firing Circuits Trigger

Striking accuracy of 20-millimeter guns on B-36 bombers is increased by adjusting firing rate to minimize dispersion of shells caused by gun-mount vibration. Phase-shift oscillator firing circuit permits operation over 600 to 900 round-per-minute range. Circuit eliminates explosion hazard of nonelectronic firing sources caused by firing pin sparking during break in contact

By **MORRIS HALIO,** Ballistic Research Laboratories, Aberdeen Proving Ground, Maryland

MACHINE GUNS are normally operated in the free-fire mode, their natural firing rate being determined by various ballistic parameters. When the B-36 bomber's 20-mm guns, which are mounted in pairs on flexible turrets, were fired at their natural rate, vibration of the mounts produced excessive dispersion of the shells. It was discovered that maximum accuracy could be obtained by adjusting the firing for an optimum rate. Mechanical switches and commutators proved to be impractical and it was decided to employ an electronic approach to the problem.

Firing Circuit

Figure 1 shows the block diagram and Fig. 2 the circuit of the system developed to control the firing rate of the machine guns.

The frequency of phase-shift oscillator V_1 is made variable to permit operation over the range of 600 to 900 rounds per minute. Shaping amplifiers V_{2A} and V_{2B} consisting of limiters and differentiators, convert the sinusoidal output of V_1 into the pulses depicted in Fig. 1.

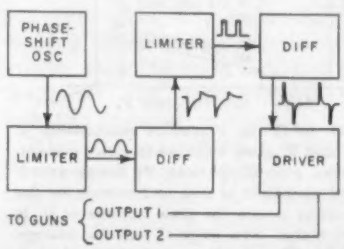
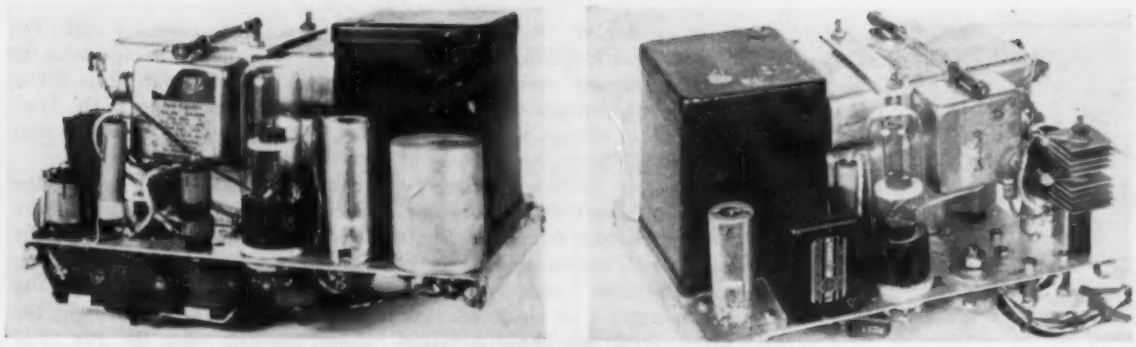


FIG. 1—Firing system for B-36 guns

The pulse output of the second differentiator triggers the driver stage V_3, a 2D21 thyratron, causing its plate capacitor to discharge through the tube, charging the cathode capacitor. Extinction of the thyratron is accomplished by this bootstrap action of the cathode circuit. The time constants of the plate and cathode circuits permit recharging of the plate capacitor between firing cycles while still permitting a pulse of the proper duration and amplitude to trigger the following stages.

Switch Tubes

Power stages V_4 and V_5 are essentially switches which furnish firing energy to the primers. Their outputs, which are triggered by the driver, are led separately to the guns on the twin mount.



Inside views of electronic firing control for B-36 machine guns mounted in flexible turrets

Airborne Machine Guns

Since the primer requires a high peak current, the only tube found to do the job reliably was the strobotron, manufactured variously as the SN4, 1D21 and 631P1. This is a cold cathode tube, as shown in Fig. 3, whose cathode consists of metal coated with electron-emitting cesium. A ceramic insulator surrounding the cathode supports the inner electrode, which is constructed of wire mesh screen. An outer grid made of graphite is located immediately above the ceramic insulator and an anode about an inch above that.

During operation of the tube there is a bright column of light about ¼ in. in diameter extending from cathode to anode. The discharge begins as a glow which, providing that the impedance in series with the tube is low and the current source for the tube is capable of furnishing enough power, immediately becomes an arc.

The strobotron can handle several hundred peak amperes, thus insuring proper ignition of the primer. This tube has been thoroughly field tested during the firing of many thousands of rounds and been found to operate reliably for this application.

The characteristic curves for the strobotron are shown in Fig. 4. If the instantaneous voltages of the inner and outer grids are represented by a point within the hexagon, then the tube will remain nonconducting; if an excursion of the point outside the hexagon is produced, the tube will conduct.

Firing Relay

The 6-μf capacitor in the strobotron plate circuit is charged to approximately 300 v and furnishes more than sufficient energy to fire the primer reliably and within the required ignition time. The output is connected to the normally open contact of the firing relay; the gun lead connected to the arma-

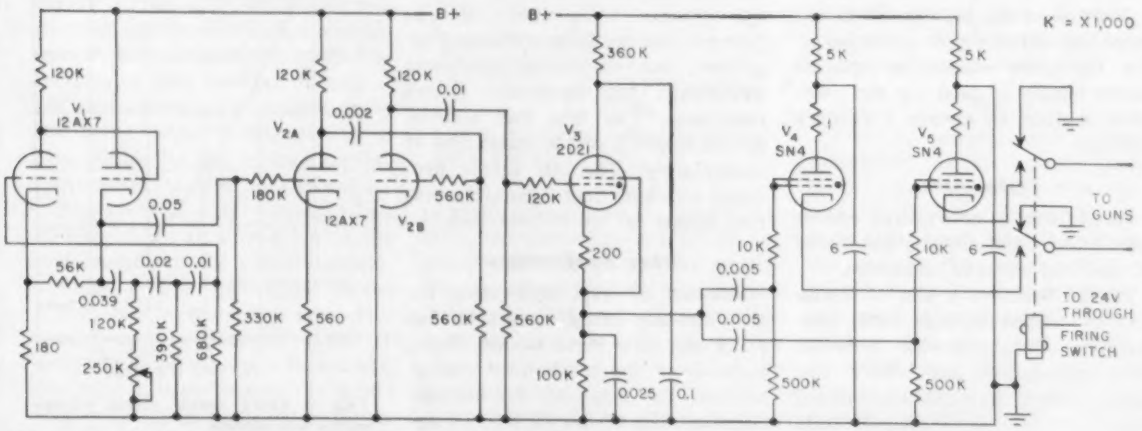


FIG. 2—Variable-frequency oscillator in firing circuit permits gun operation over 600 to 900 round-per-min range

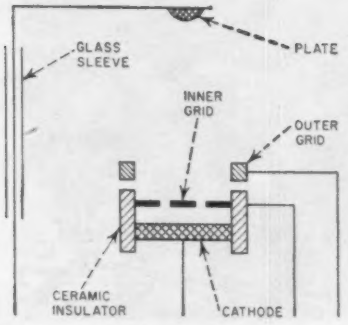


FIG. 3—Electrode structure of strobotron used to supply firing current to primers

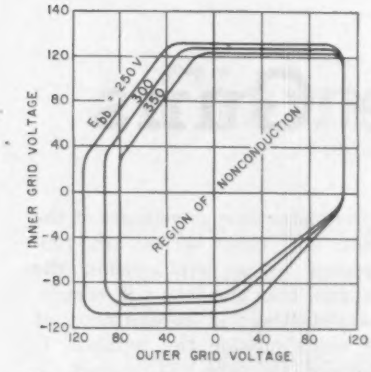


FIG. 4—Strobotron operating characteristics. Conduction occurs outside hexagon

ture is grounded during standby.

Energizing of the relay by an external firing switch ungrounds the gun lead and connects it to the cathode of the strobotron, thus making the output pulses available to the primer. The gun lead is both shielded and normally grounded to prevent spurious firing of the gun because of external fields.

Because of the high currents and large amount of ripple produced by the thyratron stages, a separate power supply is used for the oscillator section to ensure frequency stability.

Performance

In addition to undergoing endurance firings, the circuit was tested in cold and altitude chambers.

Figure 5 shows a plot of variation of output voltage with temperature. The decrease between room temperature and −80 F was approximately 50 v and was caused almost entirely by increased voltage drop across the strobotron tubes at these low temperatures.

The equipment was also subjected to stratosphere tests; variation in output voltage with altitude is plotted in Fig. 6. An increase of 50,000 feet in altitude produced a decrease of about 60 v. However, the energy output from the circuit remained well within requirements.

An additional fringe benefit derived from use of an electronic type of firing circuit was the elimination of explosion hazard. Firing of the guns which are enclosed within a turret or the body of the aircraft, generates gases.

During the normal cycle of the gun's action, the firing pin bounces and breaks contact with the primer. If a nonelectronic firing source is employed, the firing pin retains a high potential and a spark is produced during the break. This can produce combustion or detonation.

When the electronic circuit is used, the voltage is normally zero at the firing pin since the strobotron, which is effectively an electronic switch, presents an open circuit to the firing voltage. The strobotron conducts only after the firing pin is in contact with the primer. The capacitor in the strobotron plate circuit discharges and the tube extinguishes before the firing pin can break contact with the primer during gun recoil. Therefore, no spark can form.

To illustrate this principle, a gun was set up in a range and an enclosure was constructed around the gun to collect the gases, simulating operation in an aircraft. Three firing sources were used: 400-cps current; energy from a charged capacitor, not employing electronic switching; the electronic circuit described. The first two sources caused ignition of the gases almost immediately. The last source produced no such effect even after several bursts of 100 rounds each.

Other Applications

Another aircraft application for an electronic firing circuit is that for a gun on a rigid mount. Here, because of the mechanical configuration, the necessity for controlling the rate of fire to achieve optimum accuracy does not exist. On the other hand it is desirable to keep this rate as high as possible, which means operating in the free-fire mode. It is also necessary that explosion hazards be eliminated.

Based on these requirements, the circuit shown in Fig. 7 was developed. A firing switch operated by the gunner supplies a triggering voltage to an electronic circuit via a gun switch. The latter is in the closed position when the gun is in battery (a gun is in the battery position before firing and at the end of each firing cycle).

Operation of the circuit produces a voltage pulse which is fed to the primer in the round of ammunition, firing the gun. Recoil of the latter opens the gun switch which recloses when the gun returns to battery. This action triggers the circuit again, so the cycle is repeated over and over, until the firing switch is released or the ammunition is expended.

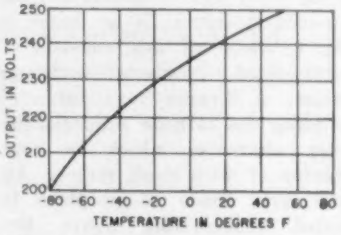


FIG. 5—Firing circuit output voltage varies with temperature

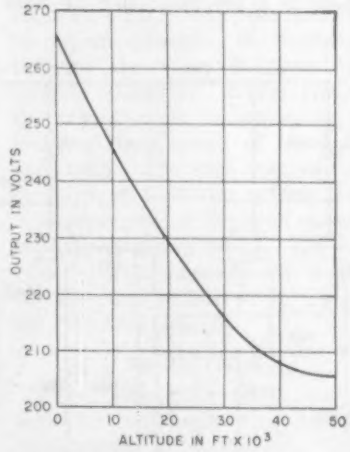


FIG. 6—Firing circuit output voltage varies with altitude

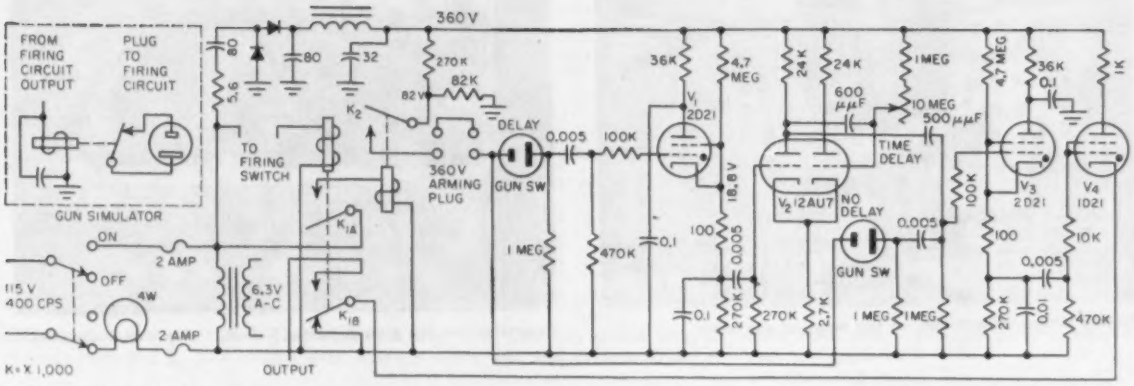


FIG. 7—Firing circuit for airborne guns in rigid mounts operating in free-fire mode for highest possible firing rate. Tube V_4, shown as a thyratron, is actually a cold-cathode type

Referring to Fig. 7, closing of the firing switch actuates relay K_1, connecting the circuit output to the gun line. A second set of contacts energizes relay K_2. Voltage from the power supply is made available through the K_2 contacts to trigger thyratron V_1 since the gun switch is closed at this time.

The thyratron output triggers monostable multivibrator V_2 which introduces a small delay between the time the gun switch closes and the time a voltage pulse is sent out to the firing line. This delay allows sufficient time for the firing pin in the gun to stop bouncing and remain in contact with the primer. This delay is necessary as opening up of the firing path would stop action of the gun.

The negative rectangular wave produced by the multivibrator is differentiated, the positive spike at the end of the time interval triggering thyratron V_3. Output of this stage is sufficient to ignite strobotron V_4 without positive bias. The interval of time between closing of the gun switch and application of the firing pulse to the primer is controllable by the 10-megohm potentiometer in the multivibrator.

Figure 8 is a calibration curve of time delay as a function of the dial reading of the potentiometer.

Since a transformerless power supply has been used, a protective arrangement is employed. After all ground connections have been made, the plug is inserted into the power line with the power switch in the off position. If the plug is oriented properly, the red-colored wrong-polarity lamp on the front panel remains extinguished and the equipment may be turned on. If the plug is inserted in the wrong direction, this lamp lights and the plug must be reversed before the unit is switched on.

Gun Simulator

A gun simulator was devised to test operation of the circuit in the laboratory and to permit localization of trouble in the field. It consists of a high-resistance relay whose coil is shunted by a large capacitor. The normally closed contacts are connected in place of the gun switch and the coil and capacitor are substituted for the primer in the gun. Before the firing switch is closed, the normally closed contacts are made up, simulating the gun in battery.

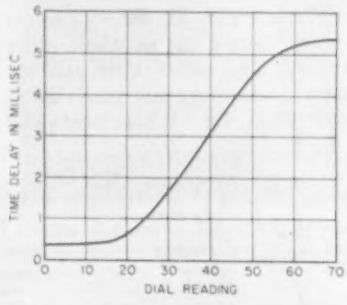


FIG. 8—Time-delay calibration for circuit of Fig. 7

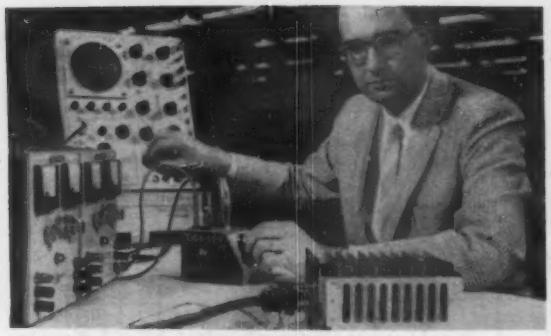
Closing the firing switch sends a voltage pulse through the normally closed contacts to the circuit input. The firing pulse at the output charges the capacitor across the relay coil, simultaneously energizing the relay. The normally closed contacts open up, simulating the condition of the gun switch when the gun fires and recoils. The capacitor discharges through the coil and after an interval of time, the potential across it drops below the holding voltage for the relay.

Deenergizing of the relay returns the normally closed contacts to the closed position, simulating return of the gun to battery. This action delivers a trigger pulse to the circuit input, repeating the cycle over and over. The capacitor value can be chosen so the repetition rate of the simulator will equal the normal firing rate of the gun.

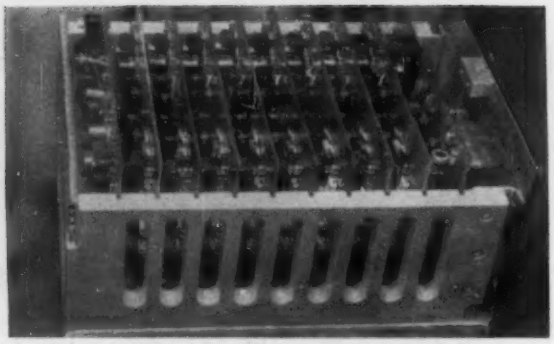
The circuit is armed by connecting a GR type 274N plug in series with the input. This is normally retained by the gunner to furnish an added safety factor.

Use

This equipment was designed principally for the Hispano (locked bolt) type of machine gun. However, it is also intended for use with other types of guns which do not require the delay feature for proper functioning and where the maximum possible rate of fire is desired. Provision has been made for bypassing this section of the circuit by including a no-delay gun switch receptacle.



Author makes adjustments on test setup of converter



Converter has ten plug-in cards: 8 digit, 1 shift and 1 comparator

Transistorized Analog-

Subminiature components and printed wiring reduce package size to 160 cu in. and power consumption is less than 4 watts in completely transistorized analog-to-digital converter that codes 0-to 5-volt inputs at maximum sampling rate of 5,000 inputs/sec with 0.5 percent accuracy. Eight binary-digit result is shifted out serially at a rate of 100,000 digits/sec

By **WILLIAM B. TOWLES** Electronics and Flight Controls, The Martin Co., Baltimore, Md.

ANALOG-TO-DIGITAL CONVERSION is necessary where the accuracy of analog data is to be maintained during transmission and processing. The experimental converter to be described was designed for coding of analog data in airborne telemetering systems.

The successive-approximation conversion process employed involves feedback subtraction in which the coder generates a voltage proportional to the count stored in it. The voltage is compared with the analog input voltage, and the count is changed until the difference falls below a specified level.

Converter Operation

An analog input voltage is applied to the comparator shown in Fig. 1. The initiate pulse, which starts the coding, sets flip-flop one, the most significant digit in the shift register, to a ONE condition. It also triggers monostable multivibrator one, which produces a delay and generates an enabling pulse that is applied to reset gate one.

When flip-flop one is set to a ONE condition, current switch one passes a precise value of direct current into the summing and weighting network. This network weights the current according to the significance of the digit it represents and passes to the comparator a voltage proportional to the weighted current.

Since only reset gate one is enabled at this time, the pulse passes through gate one and resets flip-flop one to a ZERO condition. If the voltage from the network does not ex-

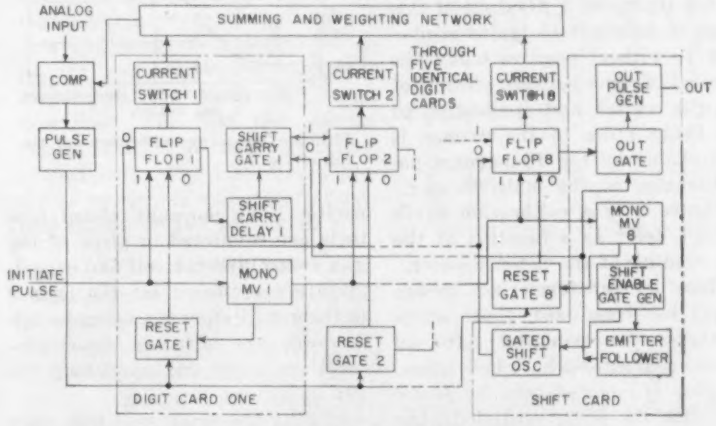


FIG. 1—Analog-to-digital converter has eight identical digit cards

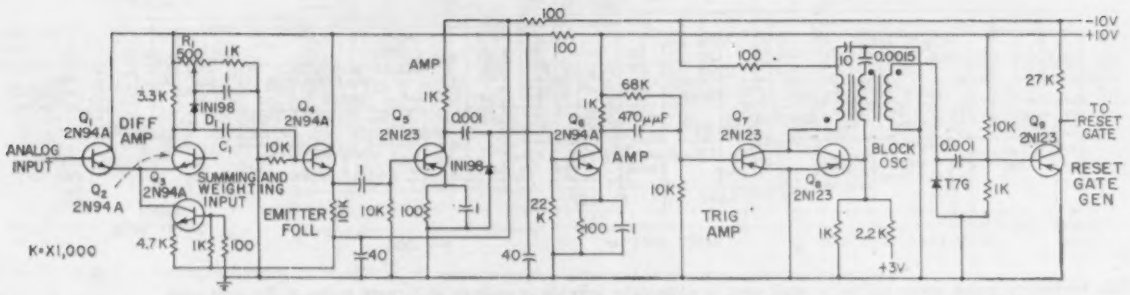


FIG. 2—Comparator action begins when summing and weighting output exceeds analog input and a negative pulse is coupled through capacitor C_1. The trailing edge of the blocking oscillator pulse activates the reset-gate generator

Digital Converter

ceed the analog input voltage, no reset pulse is generated and flip-flop one remains in the ONE condition.

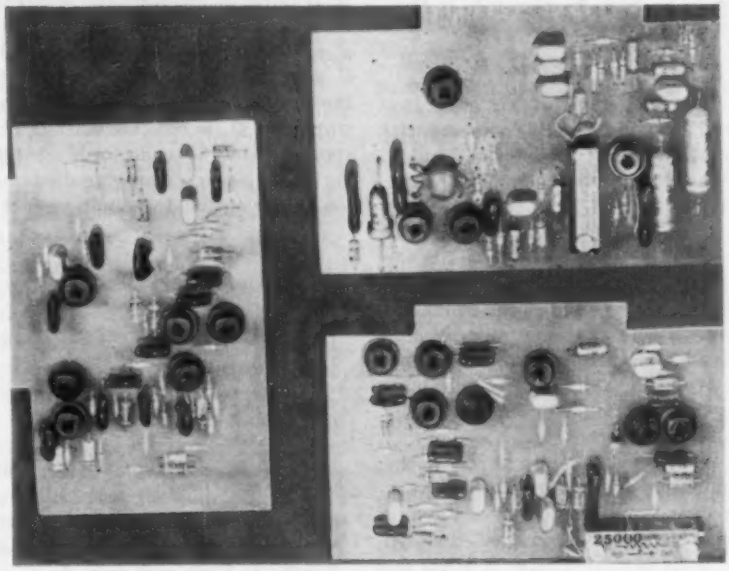
A trigger pulse derived from the trailing edge of the gate, produced by monostable multivibrator one, initiates a similar sequence in stage two.

The comparator may now receive a voltage from the summing and weighting network proportional to the sum of stages one and two weighted currents when stage one remains in a ONE condition. The total voltage is compared with the analog input to determine whether stage two should be reset.

Complete Conversion

The sequence is repeated for all stages, proceeding from the most to the least significant digit. After the stage representing the least significant digit is operated on, the binary number present in the register is the digital equivalent of the analog input voltage.

To obtain a serial output from the converter, the digital number remaining in the shift register must be shifted out after conversion is complete. The trailing edge of the pulse produced by monostable multivibrator eight triggers the shift-enable gate generator, which, in turn, enables the shift carry gates, the serial output gate and gates on the shift oscillator. Parallel-applied shift pulses then clear and return all eight shift-register flip-flop stages to ZERO condition to clear the register.



Laminated phenolic digit, shift and comparator cards are photographed with 1/32-in. foil width. Components are placed using automatic insertion

Any flip flop previously in a ONE condition triggers its shift-delay circuit at the time of a shift pulse. After a 5-μsec delay, the next flip flop is set to a ONE condition. When a flip flop is in a ZERO condition, the following one is set in the ZERO condition after the shift pulse. The shift-enable gate generator allows eight shift pulses to enter the shift register. At the end of this time, all eight flip flops in the register are in the ZERO condition and the register is cleared.

The condition of each flip flop is transmitted toward the output end of the shift register, one digit at a time, following after each shift pulse. Since the serial output gate is held open by the shift-enable gate generator, the output pulse generator is triggered every time flip-flop eight changes from a ONE to a ZERO state during shift pulse application to the register.

Presence or absence of a pulse on

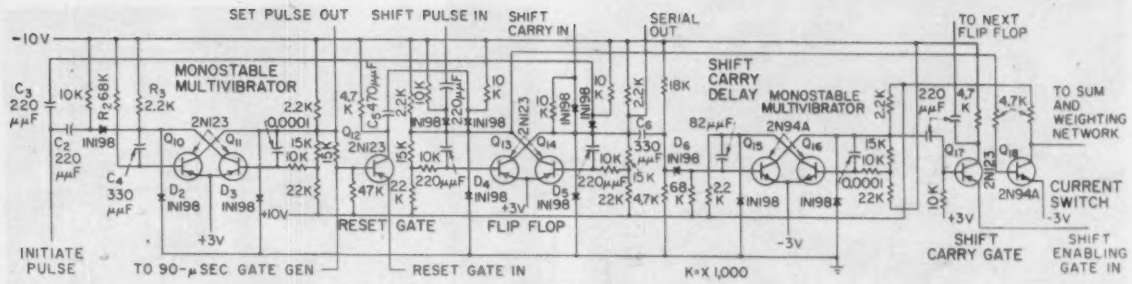


FIG. 3—Initiate pulse starts coding in digit card to ultimately provide a positive shift-carry pulse to the next card

the serial output line during a shift pulse indicates a ONE or a ZERO for a particular binary digit. The least significant digit is shifted out of the shift register first. Since the flip flops are cleared during the shifting operation, the shift register is ready for the next coding cycle as soon as shifting is complete.

Comparator

The first-stage of a comparator card shown in Fig. 2 is a differential amplifier with transistors Q_1 and Q_2 connected in the common-emitter configuration. Total emitter current of Q_1 and Q_2 is supplied by constant current source Q_3 in the common-base connection, thereby assuring freedom from common-mode effects at the output collector of the amplifier. Diode D_1 clamps the collector voltage of Q_2 to a level set by potentionmeter R_1 during the calibration procedure.

When pulse amplitude from the summing and weighting network exceeds the analog input voltage, a negative pulse is coupled through C_1 to the base of emitter follower Q_4. The emitter follower output is amplified in transistors Q_5 and Q_6, and a negative pulse is applied to the base of Q_7, the triggering amplifier for blocking oscillator Q_8. The trailing edge of the blocking-oscillator output pulse activates reset gate generator Q_9.

Digit Card

The positive initiate pulse for a digit card shown in Fig. 3 couples through capacitors C_2 and C_3 to set monostable multivibrator Q_{10} and Q_{11} and flip flop Q_{13} and Q_{14}. When the monostable multivibrator is set, transistor Q_{10} is turned-off and transistor Q_{11} is turned on. In the nonconducting condition, the collector of Q_{10} becomes sufficiently negative to bias the emitter-base junction of resetgate transistor Q_{12} in the forward direction.

Therefore, when a blocking oscillator pulse in the comparator turns on reset gate generator Q_9 (Fig. 2), a positive pulse couples through C_5 resetting the first flip flop. When the flip flop is in the SET condition, transistor Q_{14} is not conducting. Its approximately 8-v collector biases off Q_{15} and releases a clamping diode in the summing and weighting net-

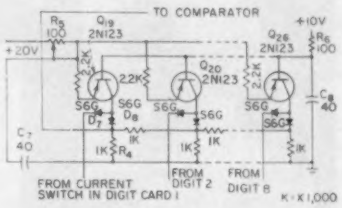


FIG. 4—Summing and weighting network consists of eight identical circuits

work, whose output rises from zero to 2.5 v.

The time constant of monostable multivibrator transistors Q_{10} and Q_{11}, determined by the values of C_4, R_2 and R_3, produces a multivibrator gate width of 10 μsec. The trailing edge of the gate is a setting input for the monostable multivibrator and flip flop on the second digit card, the next most significant digit. If a reset pulse is then obtained from the comparator, the flip flop on the second digit card is reset through gate Q_{12}, held open by transistor Q_{10} on the second digit card. Transistor Q_{15} then cuts off and a second clamping diode is released in the summing and weighting network, thus allowing its output to rise to 3.75 v.

Preventing Saturation

The collectors of monostable multivibrator transistors Q_{10} and Q_{11} are clamped to ground through diodes D_2 and D_3 to prevent transistor saturation. Similarly, diodes D_4 and D_5 prevent the flip flop from saturating.

When the flip flop resets, it triggers the shift-delay monostable multivibrator with a negative pulse through coupling capacitor C_6 and diode D_6. An enabling pulse derived from the trailing edge of the 5-μsec gate is applied to shift carry gate Q_{17}. If shift-enabling gate transistor Q_{18} in Fig. 5 is conducting, a positive shift carry pulse is applied to the flip flop on the next digit card.

Sum and Weighting

When the first flip flop shown in Fig. 3 is in a ONE condition its current switch passes a precise value of direct current from a constant-current source into the first node of the resistive ladder network in Fig. 4. The current produces a 2.5-v step at the summing and weighting net work output, or half of the maximum analog input of 5 v. If the analog input is larger than 2.5, the flip flop is not reset, and the second digit-card flip flop is triggered to a ONE condition.

Half of the d-c current flowing into the second node of the resistive ladder network adds to first node current thus developing 3.75 across output resistor R_1 (Fig. 4). The

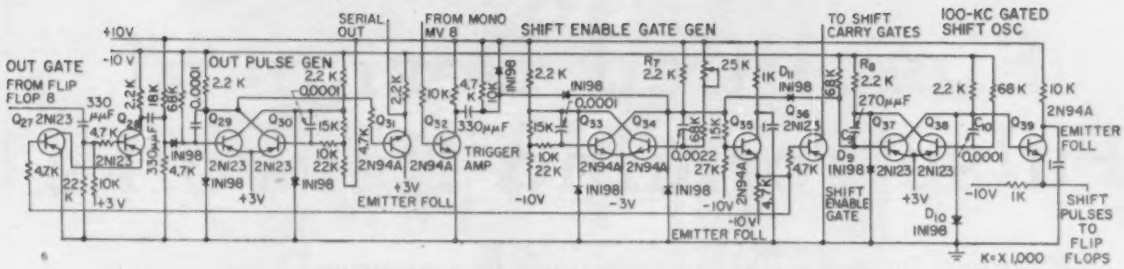


FIG. 5—Output of emitter follower Q_{35} in shift card enables output gate and shift carry gates on digit card

process repeats for the third digit card, and 1/4 of the current injected into the third node of the ladder network passes through R_1.

Transistors in the common-base configuration supply constant currents within 0.1 percent for the summing and weighting network.

When flip-flop one is in the ZERO or rest condition, transistor Q_{15} in Fig. 3 is saturated and its collector approaches emitter potential of −3v. Diode D_7 in Fig. 4 is then forward biased and the collector of the constant current transistor Q_{17} is at −2.5v. Since diode D_8 is reverse biased under this condition, constant collector current from Q_{19} passes through D_7. If the flip flop is now set to a ONE condition Q_{15} cuts off, and the cathode of D_7 rises to 10 v and is reverse biased.

Constant collector current of Q_{19} flows through D_8 and develops 2.5 v across R_1. The process continues in a similar fashion for the remaining seven digits.

Silicon point-contact diodes in the summing and weighting network provide desired high back resistance and low shunt capacitance.

Elements C_7, R_{35}, R_6 and C_8 form heavy decoupling networks to prevent supply voltage transients from reaching the summing and weighting network. Potentiometer R_5 adjusts the emitter current of Q_{19} for calibration.

Shift Card

A pulse derived from the trailing edge of the output of monostable multivibrator eight is inverted in amplifier stage Q_{36} on the shift card in Fig. 5. The negative trigger pulse sets the 90-μsec monostable-multivibrator gate generator. A 90-μsec negative gating waveform is applied through emitter follower Q_{35} to enable the serial output gate on the shift card and the shift carry gates on the digit cards. The 90-μsec gating pulse also gates the 100-kc shift oscillator, an asymmetrical, free-running multivibrator, with 2-μsec output pulses. Diodes D_9 and D_{10} prevent the multivibrator from saturating.

When the 90-μsec gate generator is in the reset condition, transistor Q_{36} is cut off and current through R_{37}, D_{11} and 68,000 ohms holds the base of transistor Q_{37} at about 9 v. Since its emitter is returned to +3 v, Q_{37} is held at cutoff. When the 90-μsec multivibrator is triggered, however, the anode potential of diode D_{11} falls to ground and the diode is reverse-biased. Base voltage of transistor Q_{37} drops exponentially toward −10 v as capacitor C_{10} charges through R_{37}.

When its base falls below 3 v, transistor Q_{37} starts conducting, and its rising collector voltage waveform couples through C_{10} to turn off Q_{36}. Oscillation continues until the 90μsec gate pulse terminates. Then, the base voltage of Q_{37} rises to 9 v, thus terminating the shift pulses.

Unequal values of collector-to-base capacitance produce asymmetrical collector waveforms of the shift oscillator. The positive shift pulses are applied to the flip flops on all eight digit cards in parallel through emitter follower Q_{39}.

During the shift operation a ONE in the flip flop on the eighth digit card produces a negative pulse at the base of transistor Q_{35} in the serial output gate. The negative 90-μsec gate pulse from Q_{36} keeps Q_{37} conducting. A positive pulse, appearing at the collector of Q_{37}, triggers the output monostable-multivibrator pulse generator. Positive multivibrator pulses feed emitter follower Q_{39} which delivers 10-v, 5-μsec pulses from a less than 200-ohm source impedance into the serial output line.

Performance

Results of linearity tests on the packaged converter show that it codes inputs in the 0-to-5-v range with an accuracy of better than 0.5 percent at a maximum sampling rate of about 5,000 inputs/sec. The overall volume of the unit enclosed in an aluminum dust cover is about 160 cu in. The measured power requirement is about 3.5 w. Approximately 725 subminiature components including 102 transistors are used.

A number of refinements can be added to the basic converter to increase its versatility. An internal reference supply using Zener diodes can be added to remove the requirement for highly stabilized supply voltages. A linear preamplifier can be added for direct conversion of low-level inputs in the millivolt range.

Digital-analog conversion can easily be incorporated by providing for direct parallel entry to the flip flops by an external binary number. Its analog equivalent voltage is then obtained at the output of the summing and weighting network. The addition of a separate shift register doubles the maximum sampling speed by allowing simultaneous conversion and shifting.

This project was supported by a United States Naval contract.

Simplified Design of Pulse-Forming Networks

Procedures for designing a five-section pulse forming network capable of producing acceptable pulse waveforms use straightforward, orderly technique that reduces engineering time and eliminates guesswork

By **K. H. RECORR,** Electron Tube Division, Radio Corporation of America, Harrison, N. J.

PULSE-FORMING networks similar to those used for pulse-testing vacum tubes are relatively inexpensive. Design of these networks by cut-and-try methods usually produces poor results and causes engineering costs to exceed labor and material costs.

A type of pulse-forming network must be selected which meets a wide range of electrical conditions and is simple to construct. The network chosen for discussion consists of a five-section capacitive circuit and a single-layer, continuously wound tapped solenoid. A common circuit employing this network is shown in Fig. 1.

Design Procedure

A method of calculating optimum design parameters is then established. Total network inductance and capacitance for the component arrangements shown in Fig. 1 are found from the relations

$$L = \frac{R_o t}{2} \text{ and } C = \frac{t}{2R_o}$$

where L is total network inductance in microhenries; C is total network capacitance in microfarads; t is pulse duration in microseconds; and R_o is characteristic impedance of the network in ohms.

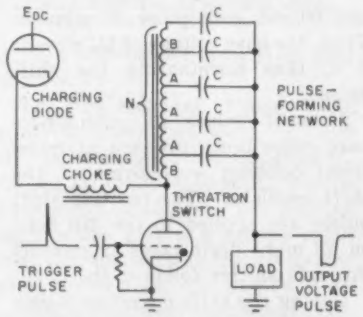
The expression used to determine a set of suitable dimensions for the coil is $F = 13.7\ r$ where F is total coil length in inches and r is coil radius in inches. It is usually wisest to choose the radius from available sizes of tubing, rod, or other coil material and then determine the necessary coil length. The length should be kept within the practical limits of 4 to 10 in.

Required number of turns per section is determined from the equations $N_A = 2.2\sqrt{L/r}$ and $N_B = 2.7\sqrt{L/r}$ where N_A is the number of turns in a center section and N_B is the number of turns in an end section. Total number of turns is found from $N = 12.1\sqrt{L/r}$. The correct number of turns per inch, which determines the size of wire used, is found from $TPI = 0.9/r\ \sqrt{L/r}$.

Since the exact value of TPI is seldom found in wire tables, the designer must select a value that does not correspond to the calculated value. This procedure results in a slight deviation between computed and actual performance. A less obvious error is introduced because perfect windings are rarely made and, therefore, the final coil contains a different number of turns per inch than calculated. The last important source of error derives from the variance between stated and actual capacitance. To minimize this error, low-tolerance capacitors should be used. Pulse-width error introduced by all these sources is generally not more than two percent.

The final step consists of standardizing the physical configuration of the network and substituting actual values for the components. An option table should be provided on the network drawing as shown in Fig. 1.

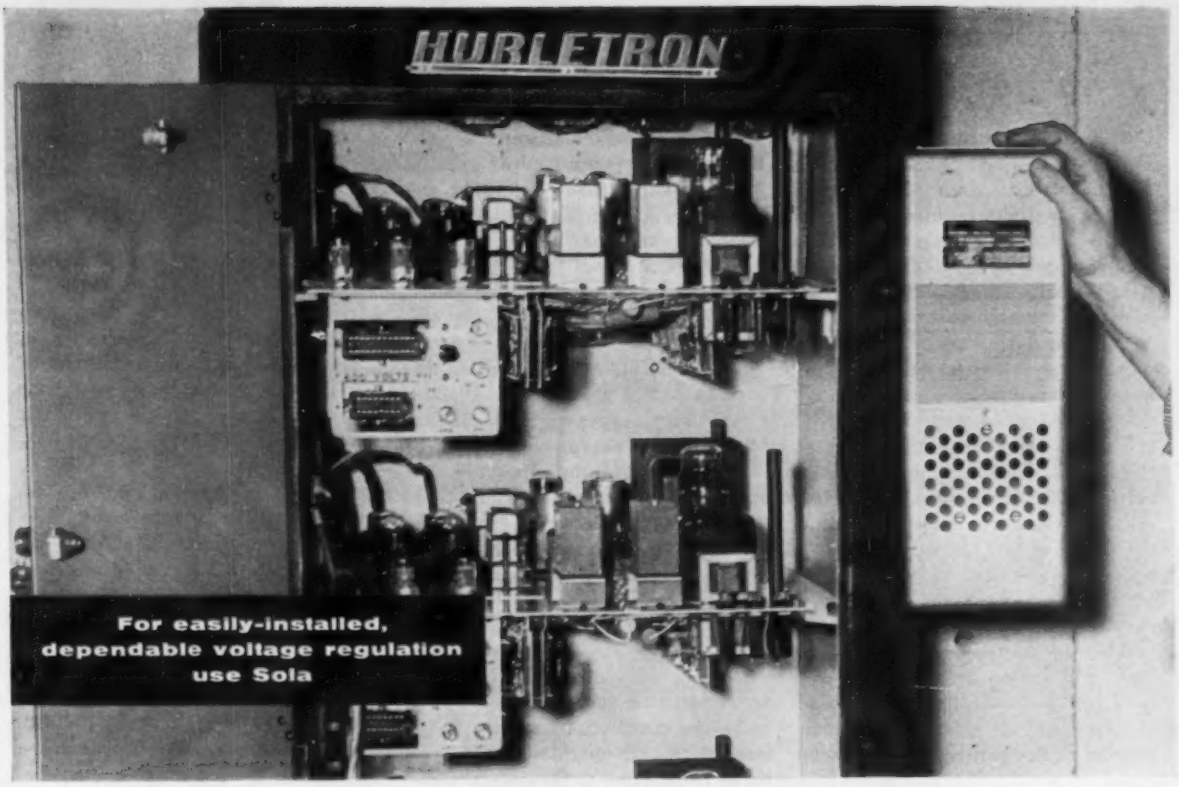
Each modification of the pulse-forming network is shown with its unique combination of pulse-width duration.



OPTION TABLE

	DESIGN 1	DESIGN 2	DESIGN 3	DESIGN 4	DESIGN 5
L	225	20	6-1/4	12-1/2	37-1/2
C	0.022	0.01	0.002	0.004	0.012
N_B	57	24	13-1/2	19.2	23.4
N_A	[illegible]	20	11	15.6	19.1
F	6-7/8	3-1/2	3-7/16	3-7/16	6-7/8
W	22 EN	22 EN	16 EN	20 EN	15 EN
Z_O	45	20	25	25	25
T_P	10	2	1/2	1	3

FIG. 1—Common circuit employing a pulse forming network. Network is charged through charging diode and choke. Trigger pulse fires thyratron and network discharges through load which can be a resistor, pulse transformer, tube under test or the like. All capacitors must have same value. Solenoid must be tightly wound



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3 **Plate-Filament*:** Regulation is ±3% with line input between 100-130v . . . plate and filament windings are combined on a single, compact core for chassis mounting . . . good isolation of input and output circuits . . . automatic, static-magnetic regulation.

4 **Filament*:** Regulation ±1% with input voltage fluctuations up to ±15% . . . 6.3v output for large numbers of electron tubes . . . current-limiting action minimizes cold inrush currents, also protects against damage from load faults . . . 75-80% efficiency.

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Weather Stations Are Air Dropped

WEATHER TRANSMITTERS, parachuted from aircraft, are providing the Navy with data from remote locations without requiring an operator. Called the Grasshopper, the systems provide wind direction, wind velocity, temperature and atmospheric pressure.

Weather data is transmitted with identifying call letters at predetermined intervals.

Designed, developed and built by the U. S. Naval Avionics Facility, the Grasshopper is completely automatic. When dropped, a static cord releases tie-down cables, enabling the tail cone to be ejected. This allows the parachute to be deployed, and at the same time pulls a pin that starts an erection delay timer.

When it hits the ground, the locking pin of the parachute ground-release mechanism falls free because of the removal of the station's weight. The parachute is disengaged.

The station remains in the horizontal position until the erection-delay timer closes a contact to fuse the wire that holds a spring-loaded self-righting hammer valve. Then gas pressure actuates the post release, leg release and leg jacks, forcing the station to a perpendicular position. Positive support is provided by the legs mechanically locking themselves in position.

About 15 seconds later, a wire holding the spring-loaded antenna hammer valve fuses, releasing the remaining gas pressure to erect the telescopic antenna.

Operation from this point is governed by a programing clock. At predetermined intervals, the clock starts the transmission sequence. First, all tube filaments are allowed to heat for 30 seconds. Operating voltages are then applied to the entire equipment.

At the beginning of transmission, the station identifies itself by sending its call letters. Then each weather transducer in turn is switched into a circuit to operate a servo system that selects the code letters corresponding to the weather information. To ensure adequate reception, each of the code letters is transmitted several times.

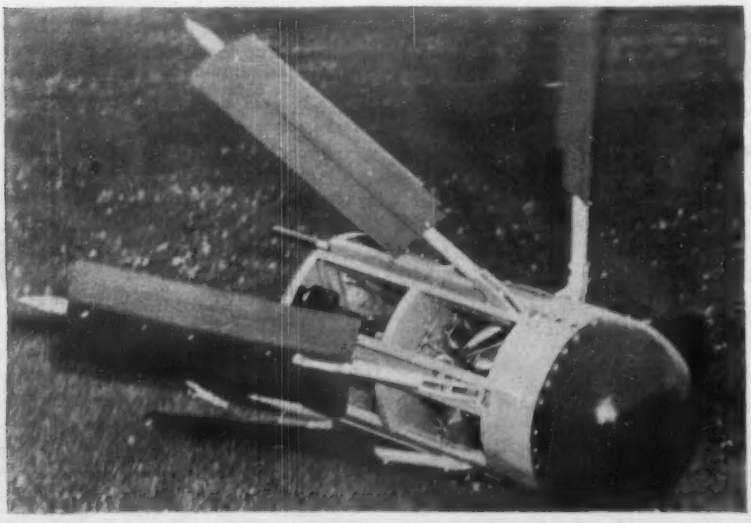
At the completion of the transmission, a cam-operated switch returns the system to its normal non-operating condition until the program timer initiates the next transmission.

The wind-direction transducer is a weathervane that is connected to a potentiometer by means of a ball-bearing mounted shaft through the pedestal of the anemometer assembly. This transducer uses the physical structure of the weather station as its directional reference rather than the earth. It is necessary, therefore, to know the direction in which the weather station is oriented. To determine this, a red arrow that is clearly visible from the air is painted on the legs of the station. Wind-direction information transmitted by the station is based on the heading of the arrow equal to zero degrees.

The wind-measuring method uses a propeller-driven four-pole magnet and a spring-loaded aluminum drag cup. The drag cup is placed in the magnetic field of the permanent magnet. When the magnet rotates because of the action of the wind on the propeller, a rotational force is imparted to the drag cup that is proportional to the speed of rotation of the magnet.

A linear spring is anchored to the drag cup by the rotating magnet. A potentiometer is connected to the drag cup shaft. By properly adjusting the strength of the magnetic field and the strength of the retaining spring, the anemometer may be calibrated to read wind speeds from zero to 80 knots.

The temperature transducer consists of a 360-degree potentiometer actuated by a spiral core of bimetal. The core is wound so that it can turn the potentiometer as much as 720 degrees over the temperature range of −70 to 140 F. The instrument should vary between zero and 2,000 ohms from −70 to −30 F. Then it drops back to zero ohms as temperature rises. With further rise, resistance continues to increase until it again reaches approximately 2,000 ohms at 140 F.



After being parachuted, legs are released forcing weather transmitter into vertical position. Timer will cause transmitter to send weather information at predetermined intervals

Magnetometer Is More Sensitive

MORE SENSITIVE magnetometer, for measuring magnetic forces originating inside the earth as well as those coming from space, has been perfected by two Department of Commerce scientists.

The instrument operates by passing a light beam through a tube containing a small quantity of vaporized rubidium. The light absorbed indicates the strength of the magnetic force.

Explanation is that light absorbtion depends on motion of the elec-

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SC-18-1	0-18	0-1	.02	.2	8⅛"	4⅛"	13⅝"	275.00
SC-18-2	0-18	0-2	.01	.1	8⅛"	4⅛"	13⅝"	325.00
SC-18-4	0-18	0-4	.005	.05	19"	3½"	13"	450.00
SC-36-0.5	0-36	0-0.5	.08	.8	8⅛"	4⅛"	13⅝"	275.00
SC-36-1	0-36	0-1	.04	.4	8⅛"	4⅛"	13⅝"	325.00
SC-36-2	0-36	0-2	.02	.2	19"	3½"	13"	465.00
SC-3672-0.5	36-72	0-0.5	.15	1.0	8⅛"	4⅛"	13⅝"	350.00
SC-3672-1	36-72	0-1	.08	.8	19"	3½"	13"	595.00

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trons in the rubidium molecule. The molecular motion in turn is affected by the magnetic field forces around the tube.

Developers of the new instrument, T. L. Skillman of the Coast and Geodetic Survey and P. L. Bender of the National Bureau of Standards, say it will give geophysicists a new tool. Instruments using the principle will be light, simple and highly miniaturized. They will be suitable for use in rockets and satellites, and may even be part of planned moon probes.

Their use in moon probes will help scientists determine whether the moon has a magnetic field. It is believed that, if there is a field, it will be so weak that present instruments would not be able to detect it.

Applications of the rubidium magnetometer are also anticipated in prospecting for oil and metals.

Distress Transmitter Is Hybrid

By **HENRY B. WEISBECKER** Project Engineer, Simonds Aerocessories, Inc. Tarrytown, N. Y.

TRANSISTORS and tubes are combined to get required power output from minimum power input in a distress transmitter. The usual hybrid design was reversed in that tubes are used in the power output and driver stages.

The system operates on both 500 kc and on the 8.326-mc distress frequency. A code-wheel operated photoelectric flip-flop accomplishes band switching automatically. The same wheel is used to key the transmitter in a predetermined code.

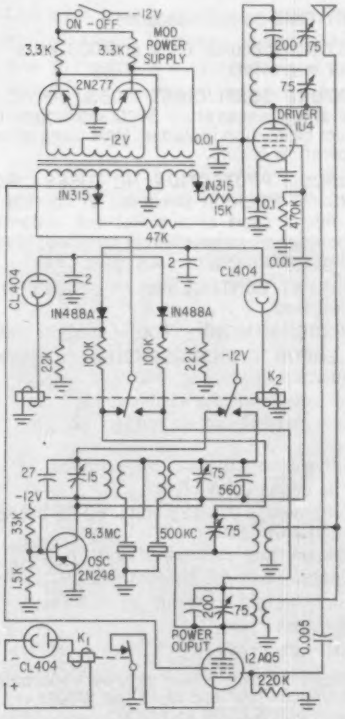


FIG. 1—Complete transmitter shows how relay K_1 through code wheel encodes output and relay K_2 switches frequency

The transmitter operates from a 12-volt battery and requires no cranking of a generator by the operator. It provides about 5 watts output with a current consumption of 1.5 amp from the battery.

The modulator-power supply shown in Fig. 1 uses a pair of 2N277 transistors in push-pull. It generates a square wave of 1,000 cps. Output from a tap on the secondary of a toroidal step-up transformer is rectified for screen and plate voltage for the 1U4 driver. A-c from this tap is applied directly to the screen of the 12AQ5 output tube. High-voltage a-c is applied by the band-switching circuit through the appropriate tank circuit to the plate of the 12AQ5. Applying the 1,000-cps signal directly to the plate and screen of the output tube assures 100-percent tone modulation of the transmitter. It also eliminates the need for producing a high d-c voltage for the tube.

Output from a separate winding of the transformer is rectified to furnish 1.5 volts d-c for the driver filament.

A 2N248 transistor is used in the oscillator, which is crystal controlled at both frequencies. The tank circuit for the oscillator is switched by the photoelectric band-switching circuit. Oscillator output at one of the two operating frequencies is coupled to the driver. The tank circuits in the driver for each of these frequencies are connected in series.

A motor-driven code wheel, a bulb and three photocells key the transmitter and switch frequency once a minute. To key the transmitter, the bulb produces light which falls on a photocell through the code wheel. The wheel is translucent or opaque, as called for by the coded information. The light on the photocell actuates relay K_1. The relay contacts, which are in the cathode circuit of the output stage, key the transmitter.

For band switching, a special slit in the code wheel passes light only once per code-wheel revolution. The photocells operate relay K_2 as a flip-flop. With K_2 at one of its two positions, light falls on both photocells through the slit. Current flows in the opposite coil, pulling the arms of the relay toward that position. When the originally closed contacts

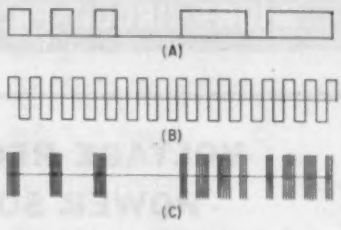
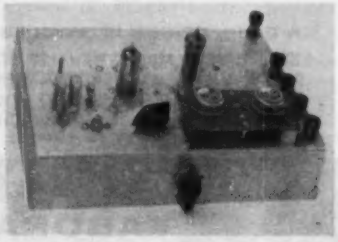


FIG. 2—Portion of S-O-S produced by code wheel is shown at (A). 1,000-cps square wave generated by modulator (B) and modulated output signal (C)

are opened, current in the coil would normally cease flowing, but this is prevented by a 2-microfarad capacitor, which, in discharging, keeps current flowing long enough for the arms to reach the opposite side.

When this is accomplished, light is no longer present and the relay remains in the new position. On the next light pulse, a similar ac-



Hybrid distress transmitter uses two tubes and three transistors to transmit coded output at two frequencies

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New 6AF3 and 12AF3 permit TV set-makers to profit more fully from economies of automated production.

Two new Tung-Sol damper diodes—6AF3 and 12AF3—bring TV manufacturers substantial dollar-savings through increased efficiency. Modern automatic assembly equipment is better able to process the miniature, button-stem dampers than prior octal-base types. Also, the new types allow standardization of tube and socket size—a big plus in printed circuit usage.

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The economy and top-flight quality of the 6AF3 and 12AF3 characterize the entire Tung-Sol tube line. For complete data on the new miniature dampers . . . to fill any entertainment socket, contact: *Tung-Sol Electric Inc., Newark 4, New Jersey.*

New Tung-Sol miniature dampers compared with types they replace

	BASING	LOAD-RATING	HEATER-RATING
6AF3, 12AF3	Miniature	185ma*	6.3v, 1.2a 12.6v, 0.6a
6AX4GT, 12AX4GTA	Octal	125ma†	6.3v, 1.2a 12.6v, 0.6a
6AU4GTA, 19AU4GTA	Octal	190ma†	6.3v, 1.8a 18.9v, 0.6a
12D4	Octal	145ma†	12.6v, 0.6a

*According to Design Maximum System of Ratings
†According to Design Center System of Ratings

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tion returns the relay to the original position. Thus the relay is thrown to its opposite position on each light pulse. Its contacts switch 12 volts d-c to the appropriate tank circuit in the oscillator and high voltage a-c to the appropriate tank in the output stage.

Frequency Modulator Covers 25-75 kc

By **P. S. BENGSTON**, U. S. Naval Ordnance Lab, Silver Spring, Md.

FREQUENCY changes from 25 to 75 kc are linear with changes in input voltage within about one percent in a specially designed modulator. The circuit can be easily modified for other frequency ranges.

The modulator was designed for use with magnetic tape recorders. The tapes were to be recorded to saturation, so a nonsinusoidal output from the modulator would be satisfactory.

The unit is linear over wide deviations with no delayed rise or overshoot with a step function input. The modulator is as sensitive as possible, consistent with good stability; sensitivity is easily adjustable.

Other design requirements incorporated in the unit are that it is relatively unaffected by nuclear

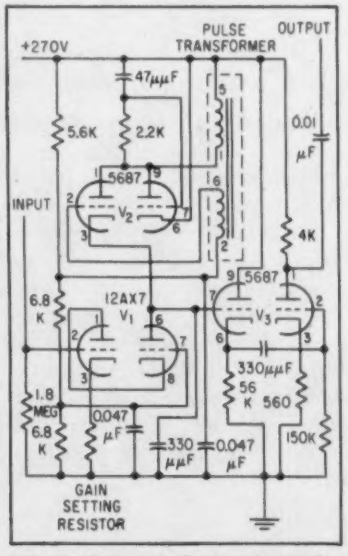

FIG. 1—Capacitor C_f is primary frequency-determining element in frequency modulator

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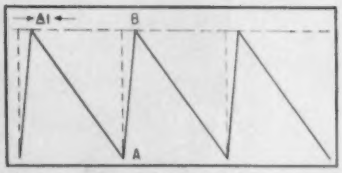

FIG. 2—Trailing edge of output waveform of modulator can be varied with a high degree of linearity

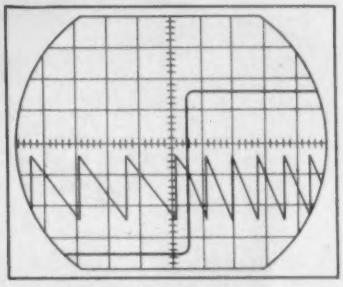

FIG. 3—Rapid change of frequency and absence of ringing were noted when step function input was applied

radiation and is able to withstand at least 30 g's acceleration. The final circuit is suitable for quantity production.

The circuit is shown in Fig. 1. It produces the voltage waveform shown in Fig. 2 across the primary frequency-determining capacitor, C_f.

Frequency of the sawtooth generator is determined by the amplitude AB, the slope of the trailing edge of the waveform and the flyback time, ΔT. Slope of the trailing edge can be varied with a high degree of linearity. Flyback time is constant. Amplitude may vary slightly; its reproducibility determines random stability.

At the beginning of a cycle of

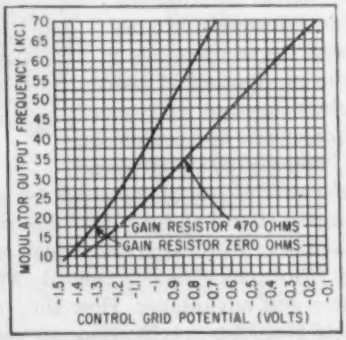

FIG. 4—Plot shows linear relationship between frequency and voltage input with zero and 470 ohms of gain-setting resistance

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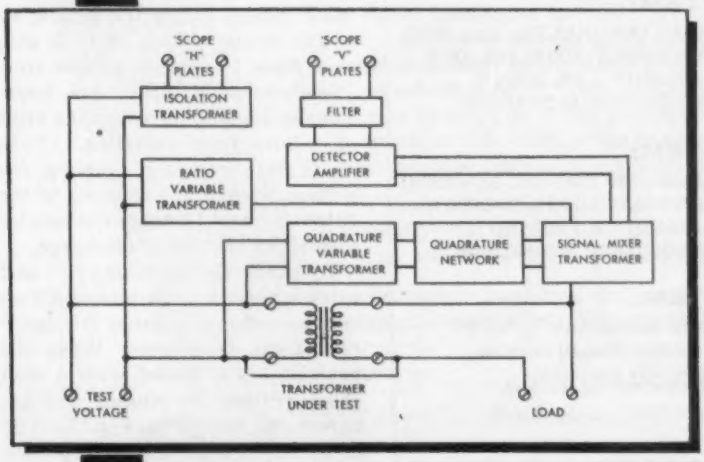
The Transformers, Inc. Model 214 A. C. Ratiometer is a precision instrument to measure any voltage ratio from 0.000001 to 1.111111. Transformer ratios can be accurately measured at "no load" or under any required load.

The Model 214 Ratiometer is designed for use between 25 cps and 2,500 cps. It is supplied with plug-in filter and quadrature units for 400 cps operation. Plug-in units for any other frequency are supplied to order.



The Ratiometer consists of two precision variable transformers, a calibrated quadrature injector, a filter, and a pre-amplifier. Block diagram indicates connections of the various components within the instrument.

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25 cps to 2,500 cps

MAXIMUM VOLTAGE

Twice the frequency in cps, or 250V, whichever is lower.

PRICE

Model 214 Ratiometer, complete with 400 cps plug-in filter and quadrature units $1235

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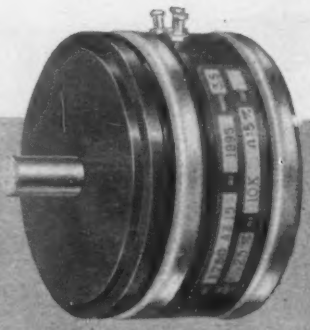

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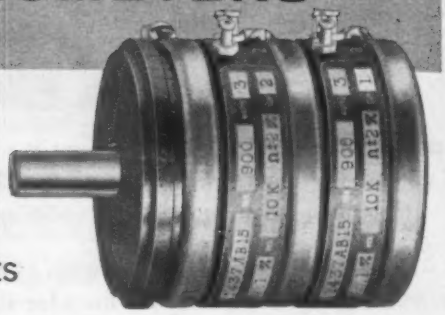

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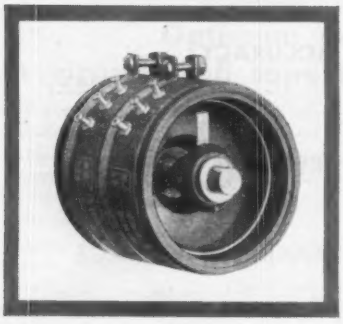

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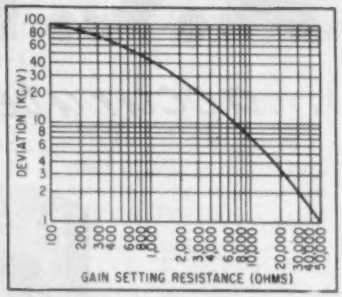

FIG. 5—Plot shows relationship between sensitivity and the value of the gain-setting resistor

operation, C_f attempts to charge to the supply voltage through V_2 by regenerative blocking-oscillator action. Actual peak voltage and charge time are dependent on pulse transformer characteristics and transconductance of the charging tube.

When the transformer field collapses, positive voltage on the first cathode of V_2 is far in excess of cutoff. Capacitor C_f begins to discharge through V_1 at a constant rate. This rate depends on modulator input voltage to the first grid of V_1 and on the gain-setting resistor. When the voltage of C_f drops below cutoff for V_2, the cycle is reinitiated. Cutoff is determined by plate supply voltage and the divider voltage on the first grid of V_2.

The second section of V_2 is used as a diode to dampen flyback ring. (Semiconductor diodes are intentionally avoided to reduce the risks of failure from radiation.) Tube V_3 is used only for coupling the voltage waveform across C_f to the output without loading or otherwise disturbing the linear discharge.

By changing the value of C_f and using a pulse transformer of different characteristics, other frequency ranges can be covered. When the modulator was tested with a step function input, no ringing was apparent, as shown in Fig. 3. The transition from the base frequency to a higher frequency was accomplished within the time required for one cycle of the base frequency.

If the gain-setting resistor terminals are shorted, the best sensitivity (about 100 kc/volt input) can be obtained, as shown in Fig. 4 and 5. Drift was about 2 percent of base frequency from a cold start

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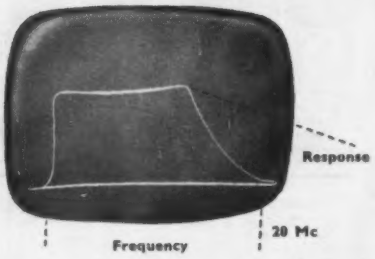

MARCONI 20-Mc SWEEP GENERATOR TYPE 1099

Abridged Specification

Frequency Swept Output: Frequency Range: Lower limit 100 kc, Upper limit 20 Mc. Output level: Continuously variable from 0.3 to 3 volts. Output Impedance: 75Ω. *Time Base:* Repetition Rate: 50 to 60 cps. Output for c.r.o. X deflection: 250 volts. *Frequency Markers:* At 1 Mc intervals; every fifth pip distinctive and crystal controlled. Tubes: 6AK5, 6BH6, 5763, 6BJ6, 6CD6G, 6BE6, 12AT7, 12AU7, 6C4, 5V4G, OA2, 5651.

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Speed Radar Uses Transistors

DISCRIMINATION between vehicles only 8 ft apart is claimed for a British speed-checking radar. Horizontal beam width of between 2 and 4 degrees enables the system to separate automobiles in dense traffic.

The radar, produced by Marconi Wireless Telegraph Co., Ltd., can be locked on an individual vehicle at the operator's discretion.

Transistors and printed circuits are used extensively in the Doppler radar to achieve compactness, light weight and reliability. The complete equipment, Transmitter-receiver, antenna and meter unit, weighs only 21 lb.

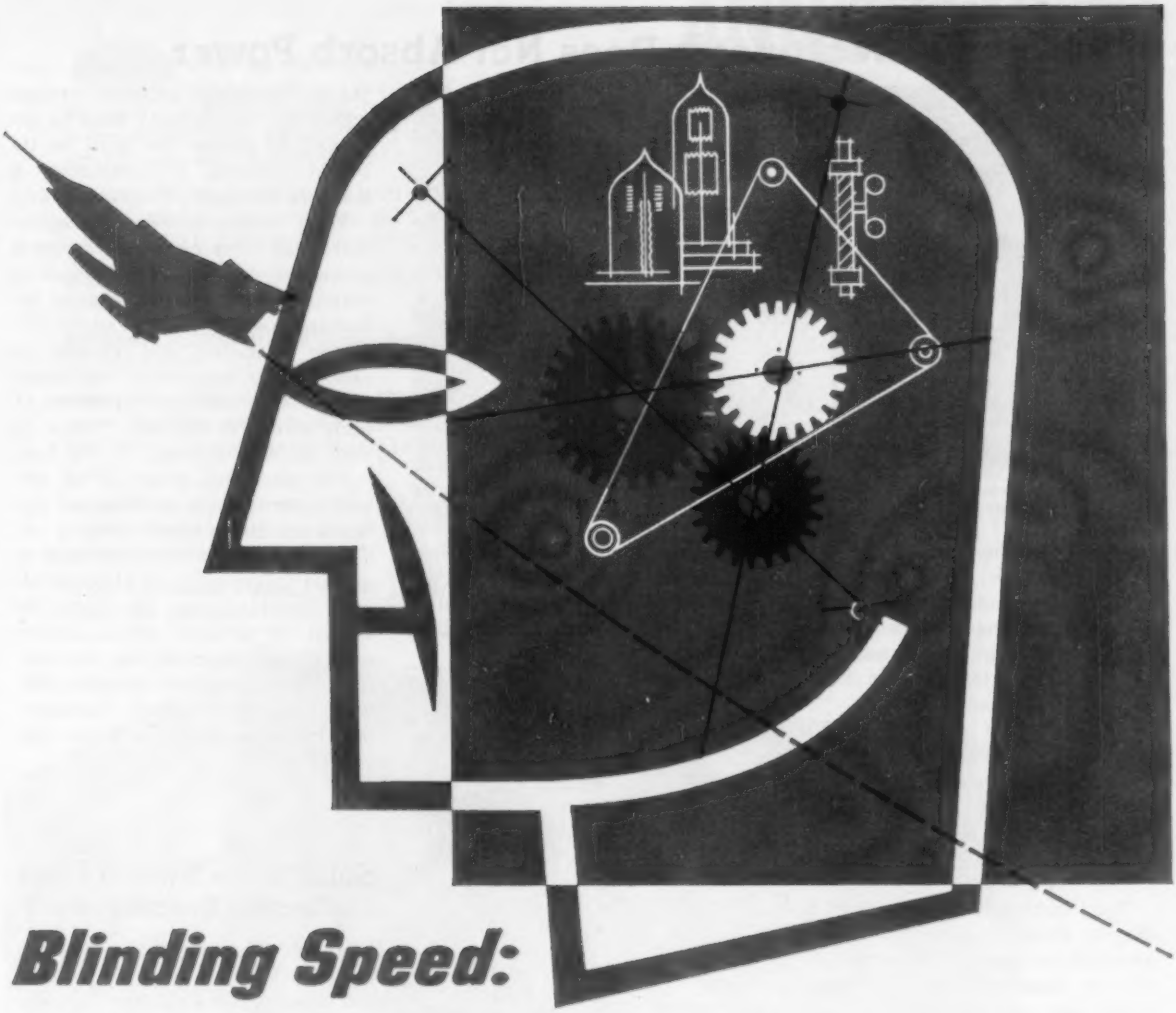
The natural squint angle of the antenna is such that, when the latter is physically at right angles to the road, the transmitted beam is directed at the required angle of 20 degrees to the line of traffic.

The change in frequency of the reflected beam is converted into a voltage that is applied across the meter. Calibration of the meter is in both mph and kph, and the system covers the speed range from 2 to 80 mph with an accuracy within one mph.

The equipment operates in the X band and provides a c-w output from 4 to 10 mw. Output from a klystron is fed into a slotted waveguide antenna with flare. This provides a working range between 8 and 150 ft.

The standard version of the equipment incorporates a single-channel waveguide system. If discrimination between near and far-lane traffic is required, a double-channel waveguide system can be fitted in place of the single channel. The double-channel system can be switched to monitor either lane at the operator's discretion.

The equipment operates on 9 volts d-c stabilized from a 10 to 16-volt supply. Power consumption is 2 amp from a standard 12-volt automobile battery.



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Microwave Wattmeter Does Not Absorb Power

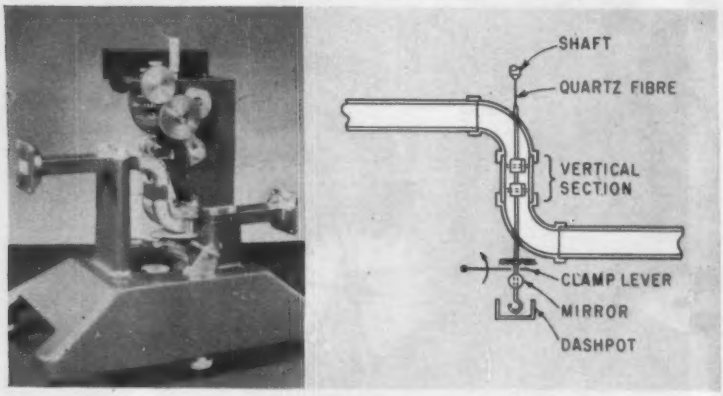


FIG. 1—Microwave power produces a rotating torque proportional to the square of the electric field

POWER LOSS when making measurements with the X-band wattmeter shown above is only slightly greater than the loss would be in the same length of waveguide. Pipes, water tank, pump and temperature control gear are not needed.

Measurements can be made in the power range of 10 to 200 watts over the frequency range 8,690 to 9,840 mc. If the power source is pulsed, the wattmeter will read the mean power, but the peak power should not exceed 500 kw.

The instrument developed by Wayne Kerr, Philadelphia, Pa. is an absolute standard since the calibration depends only on mass, length and time.

General arrangement of the instrument is shown in Figs. 1 and 2. The wattmeter consists essentially of a short vertical section of waveguide, connected by E-plane bends to horizontal input and output sections, and containing a movable element. The movable element consists of a glass tube to which two thin metal vanes are attached. The vanes are separated by one quarter guide wavelength at the midband frequency. A small mirror fixed to the lower end of the glass tube is used in conjunction with a lamp and scale to indicate the angular position of the movable element.

The movement also carries a locking cone and lever to clamp the suspension when the instrument is not in use. The lower end of the suspension dips into a dashpot containing silicone oil, thus ensuring "dead-beat" response.

The movement is suspended from a vertical shaft by a 15-micron-diameter quartz fiber. Two dials and a vernier indicate the angular position of the shaft.

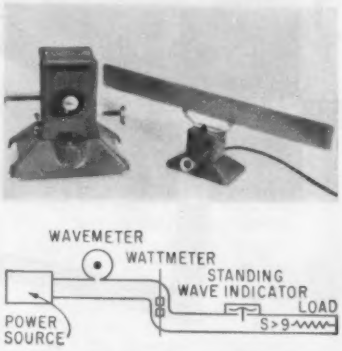


FIG. 2—X-Band wattmeter and scale (top) General arrangement for power measurement (bottom)

The ends of the horizontal guides are blocked with half guide wavelengths of expanded polythene to screen the vanes from drafts. The base of the wattmeter rests on three leveling screws, and a spirit level is built into the base.

Power Measurement

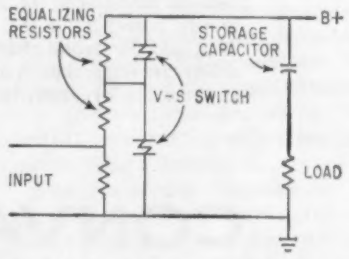
When microwave power flows through the waveguide, the associated electric field produces a torque tending to rotate the vanes into line with the unperturbed electric field. The torque produced is proportional to the square of the electric field strength magnitude, and hence to the power flow. The resulting deflection of the movement is compensated by turning the torsion head. The angle through which the torsion head must be returned to restore the vane to its initial position is therefore a measure of the microwave power.

Each vane acts like an electrostatic voltmeter connected across a transmission line. The inductive diaphragms are equivalent to inductances shunted across an electrostatic voltmeter and chosen to cancel their capacitive reactances so that the resultant impedance of each shunt is infinite. There is then no discontinuity in the line.

The mismatch produced by the wattmeter is small and does not fall below 0.9 in the band 3.05-3.45 cm. The power lost in the instrument is around 2.5 percent; it stays relatively constant over the band (to within 0.2 percent) and compares with about 1.5 percent loss of power in the same length of normal guide. When making precise measurements this loss has to be taken into consideration.

Solid-State Switch Uses Dielectric Breakdown

BY CONTROLLING the dielectric breakdown of an aluminum oxide film deposited on aluminum foil, the operating principals of an electrolytic capacitor were adapted to produce a rugged, solid-state switch. This device has the properties of a capacitor with a breakdown voltage of approximately 14 volts, a capacitance of 0.0005 μf, and a leakage resistance in the kilomegohm range. Its resistance drops to about one ohm at the critical voltage. Energy transformation is large



Typical switching circuit with two v-s switches in series

ANNOUNCING NEW MICROWAVE GENERATOR

plug-in units cover:

4,200 to 8,000 mc
6,950 to 11,000 mc

Model PMX is a versatile, portable signal generator with an extremely wide range of modulation capabilities. It is simple to operate, highly stable and accurate, and is designed for quick, easy inspection and servicing.

Interchangeable Plug-In Units (Part of Model PMX):
4,200 to 8,000 mc — Tuning Unit G 48
6,950 to 11,000 mc — Tuning Unit G 711

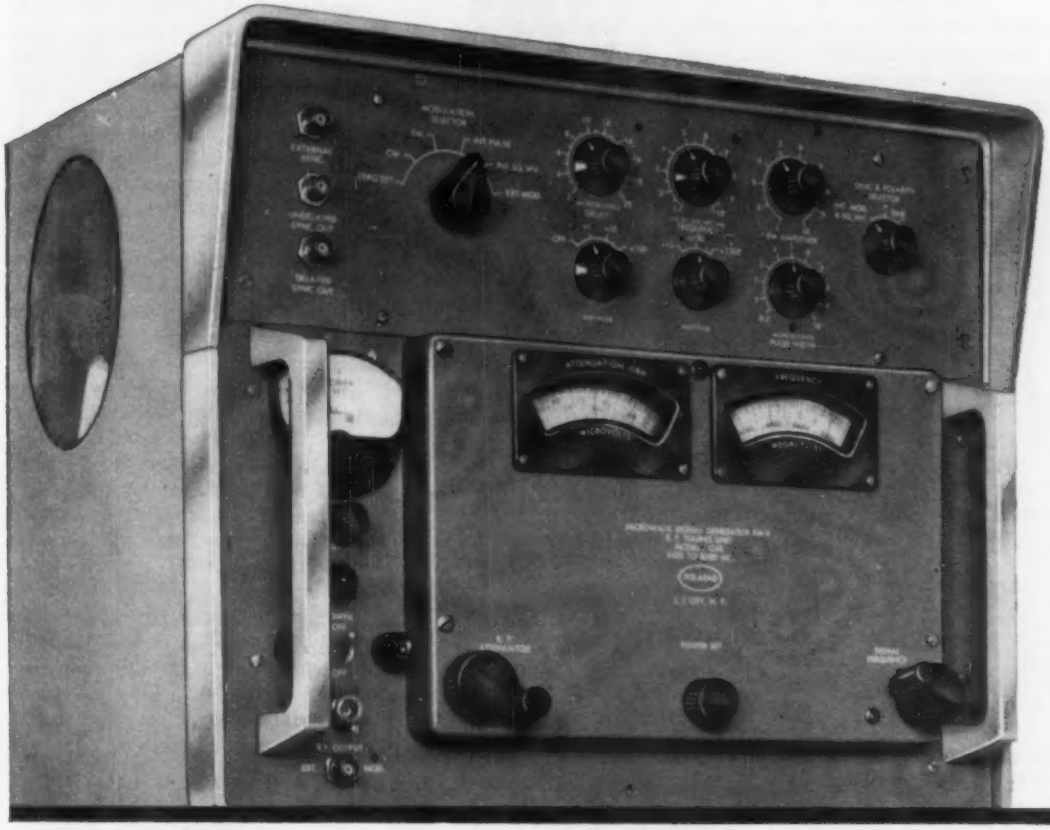
Calibrated Power Output: 0 dbm (1 milliwatt) to −127 dbm.

Modulation Capabilities: Internal or external pulse, square wave or FM.

Internal Pulse: Width, adjustable 0.2 to 10 microseconds. **Repetition rate,** 10 to 10,000 pps. **Delay,** 2 to 2,000 microseconds. **Rise and decay,** 0.1 microsecond.

Internal FM: Linear sawtooth output, 5 mc frequency deviation. Capable of internal or external, pulse or sine wave synchronization.

Output Synchronization Pulses: Positive polarity, delayed and undelayed.



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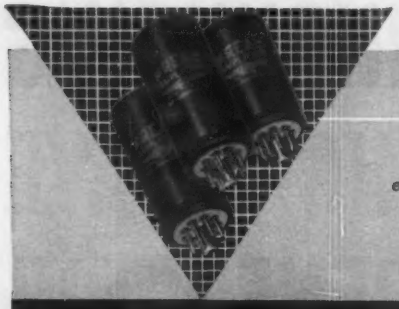
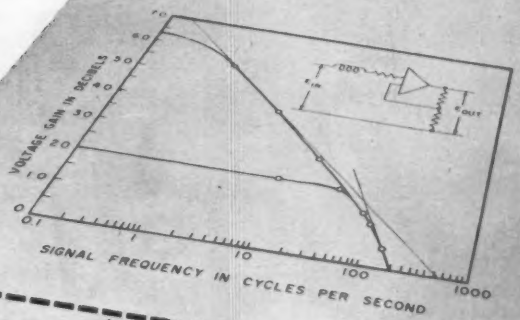


INSTRUMENT AMPLIFIERS

designed for amplification of low-level signals have exceptional sensitivity. Input of .0025 microwatts produces full output of 4 DC volts into 5000 ohms.

Low-Level Preac Magnetic Amplifiers

For sensitive thermocouples, strain gauges, and similar data sensing applications, Preac amplifiers provide low null drift. Power gain is so high (up to 60 db) that inverse feedback can readily be used to achieve special desired characteristics.



AMPLIFIER CHARACTERISTICS

Airpax Preac amplifiers are highly stable low-level magnetic amplifiers.

INPUT: DC polarity reversible. Below are input control powers in microwatts for full-scale outputs.

Type	Full-Scale Input
M-5249	0.0026 (both windings in series)
M-5250	0.011 (internal choke)
M-5251	0.025 (either winding)

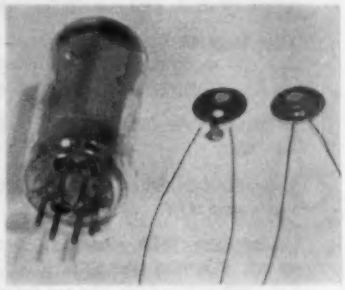
OUTPUT: DC polarity reversible ±4 DC volts into 5,000-ohm load, deviation from linearity less than 100 millivolts.

POWER SUPPLY: Less than 2 watts, about 2.5 VA, at 400 ±40 CPS and 115 ±11 RMS volts.

DESIGNERS — AIRPAX PRODUCTS COMPANY — ENGINEERS

Airpax Products Company, Seminole Division, Fort Lauderdale, Florida

since a signal with an energy content of ergs can control watts. The switch can be stacked for use at voltages higher than critical.



Switch assembled and unassembled compared with a subminiature tube

Switches with ¼ inch-diameter electrodes have a capacitance of about 0.002 μf and a dissipation factor of 1 to 2 percent; those with ⅛-inch-diameter electrodes have a capacitance of 0.0005 μf. The average breakdown voltage at −60 C is about 14 percent higher than at room temperature; at 100 C, about 16 percent lower.

Breakdown voltage of the switch is practically independent of the rise time of the breakdown pulse for periods longer than about 10 milliseconds. Breakdown voltages measured with pulses of one to five microseconds are about 80 percent higher than those observed with pulses which are longer by at least 4 orders of magnitude.

In shock tests, the switch withstood successfully accelerations of more than 7,000 g. In radiation tests, a gamma dosage of 6×10^6R and a neutron dosage of 1.6×10^{13} neutrons per cm² (fission spectrum) have had no effect on its breakdown properties.

This switch is rugged, contains no moving parts, requires no A supply, is inexpensive, and is small, not more than ½ inch in diameter and ⅛ inch in thickness. Its use will reduce overall volume as well as power requirements.

Prods Damage Sockets

APPARENT tube failures may be due to tube socket damage caused by test prods. Such damage was found by Bendix Products Division, Missile Section, Mishawaka, Ind., during final tests of the Talos missile.

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Since forced-air-cooled tubes were first introduced, equipment manufacturers have been designing their own supports, many of which have been produced by Lapp. To standardize the great variety of tube support designs, Lapp set out to design a complete line which is now available and offers the equipment manufacturer a valuable service by way of more economical production, interchangeability and availability of replacement units. Lapp Tube Supports are compact, efficient and attractive in appearance. Their duty is threefold . . . they support the tubes, insulate, and furnish an air duct which channels air over tube fins for maximum cooling. Write for Bulletin 301, with complete description and specification data. Lapp Insulator Co., Inc., Radio Specialties Division, 144 Sumner Street, LeRoy, New York.

Lapp

A controlled test was made with tubes and a test prod of the socket's nominal diameter. The prod stressed the contact leaves of the socket so that intermittent electrical continuity was produced when a tube was inserted.

All missile flights were cancelled and every socket in every missile was inspected. Of 13,500 contacts, 99 were found to be loose. Insertion of test prods was stopped.

Two Terminal Device

The switch is a two-terminal device. It has no grid to give isolation between input and output circuits. The switch is also primarily a one-time-use device and it cannot be closed directly by any voltage less than critical. Reopening can be effected however by passing d-c currents of at least $\frac{1}{2}$ ampere through the broken-down switch. Finally, the capacitance of the switch limits its use in certain applications. For example, a switch capacitance of 0.002 μf, when charged through a large resistance, would limit the use of the switch as far as short-duration pulses are concerned.

No significant effect on the breakdown voltage of the switch was observed if the resistance placed in series did not exceed 10,000 ohms. An increasing number of incomplete and multiple breakdowns occurred with greater series resistances.

Plastic Case Reduces Potting Problem

A PLASTIC CASE for encapsulated pulse transformers, which assembles to a complete transformer package provides a custom fit for all transformer sizes. Twenty-five different diameter ranging from $\frac{7}{8}$ in. to $2\frac{1}{2}$ in and twenty-five different heights from $\frac{7}{8}$ in to $2\frac{1}{2}$ in are available.

The case developed by Milton Ross Metals Co., has unobstructed access for assembling and wiring components a leak resistant press-fit seal; and a special keyway for identifying connectors and inserting the package. It is made in a variety of military approved mate-

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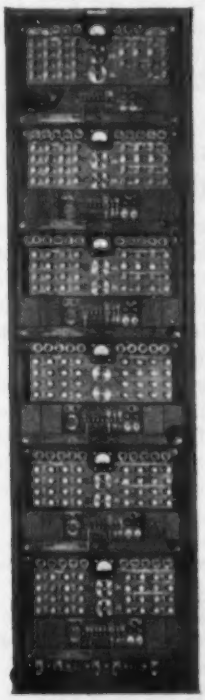

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FOUR OR 24 CHANNELS

Two miniaturized voice-multiplex systems providing four or 24 voice channels over radio or 4-wire cable are available. They have many advantages over earlier designs: high performance, small size, light weight, low cost, circuit simplicity, low power requirements, small number of tubes of a single type only, low operating cost, low maintenance and high reliability.

These systems provide a voice-channel flat within 1 db from 300 to 3500 cycles, for each 4 kc of bandwidth occupied. Each channel is equipped with hybrid, signalling, and dialling circuits for all the standard 2-wire and 4-wire loop options.

The basic unit provides an order-wire and 4 carrier-derived channels. These units can be stacked in groups of 2, 3, 4 or 5 by means of a group modem to provide 9, 14, 19 or 24 channels. Full flexibility is provided for dropping and inserting channel groups at repeater and terminal points. Moderate lengths of 4-wire cable or open-wire line may be inserted between the multiplex equipment and the radio terminals.

24-channel carrier-telephone terminal complete with hybrids, ringing and dialling circuits, and test facilities. Dimensions are 58" high, 16" wide and 8" deep. Power input 250 watts. Weight 326 lbs.

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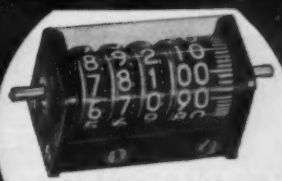
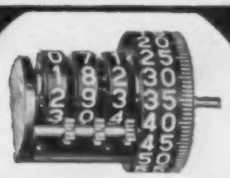
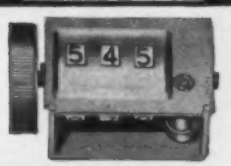


High speed, non-reset, direct reading counter to indicate increment of measurement in radar navigation instruments.

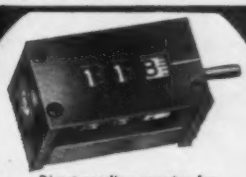
High-speed dual bank counter for use in navigating instruments. Shutter operates to close off either bank when in the minus side.



Counter assembly component of navigating instrument to indicate increments of measurement for fast, legible, direct "read-out".



Special counter for use on Tape Recorder to indicate the position of tape passing through the recorder.



Direct reading counter for navigating and directional instruments. Unit wheel graduations permit reading at 150,000 increments per minute.

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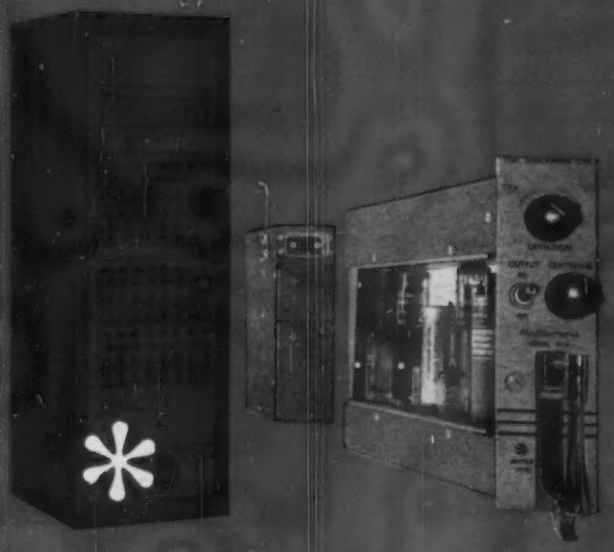

module size 2" x 7¾"... adjustable internal bias... all standard IRIG channels. The voltage controlled subcarrier oscillator, shown in this building block type FM instrumentation system, is the latest in a series of building-block components developed by Hallamore Electronics Company for the instrumentation field. Engineered for stability and flexibility, the unit designated HEC-0161 is entirely compatible with existing systems and offers unusual advantages in improved accuracy, operational simplicity, and the saving of space. A standard module case will accommodate up to six oscillators and a summing amplifier, HEC-0166. A common supply, HEC-0144, integral to the module case, provides the power in this configuration, while an individual supply, HEC-0143, is available to provide complete isolation for each transducer input.

The basic Hallamore voltage controlled subcarrier oscillator unit, HEC-0161, can be instantly converted to any IRIG telemetering channel by plug-in channel selectors, HEC-0164, and output filters, HEC-0165. Plug-in units for non-standard channels and bandwidths can be supplied. For complete specifications and operational data, write Hallamore Elec-

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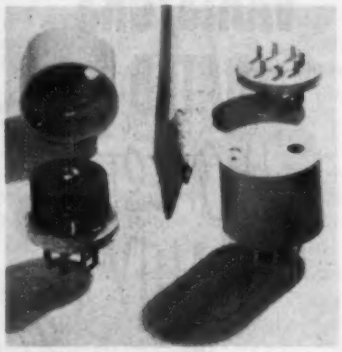
rials for operations up to 500 F. Two matched parts a circular shell for holding the potting compound and a flat plastic header with connecting pins molded-in for mounting and wiring the component, press together to form the case.



Press-fit plastic transformer cases reduce mounting and encapsulating problems

The header is flanged to fit a recessed ring in the shell. The three-surface, press-fit seal minimizes leakage of the encapsulating material.

Cases may be specified with 4-5-6-7-8-9 or 10 pins in various pitch-circle diameters up to 1½ in.

Tube Thumper Ups Reliability

INTERNAL SHORTS and microphonics in electron tubes are often sought by tapping the tube with a rubber mallet or similar tool. Earphones and a meter are used as a rough gage of the tube's condition.

An automatic device called a tube thumper is being used by Chance Vought Aircraft to provide a more objective measure of tube condition and to speed the testing process. About 20,000 tubes a year are being tested with it, primarily to improve reliability of missile electronics.

The new tester actually reduces the rejection rate on most types of tubes by eliminating human judgment factors. At the same time, it assures that all types accepted are within specifications.

A tube is plugged into the tester, and the operator pushes buttons on a console to connect the particular

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A new and welcome addition to Panoramic's long line of widely accepted and completely dependable Spectrum Analyzers, the SPA-4 covers frequencies from 10 mc to 44,000 mc in one *low-cost* compact unit that provides better *sensitivity* than found in typical multi-tuning head spectrum analyzers.

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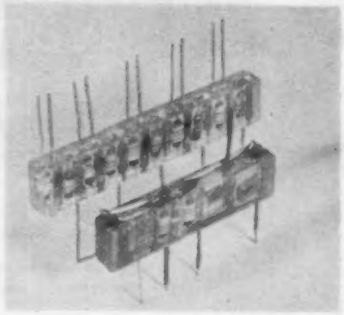
type of tube into the test circuit. Specifications for noise are set on the dials and another button pressed. The socket supporting the tube then is automatically tapped by a hammer with a force equal to 10 g's. The blow is of such short duration that no damage is done to the tube, but any loose parts will vibrate.

The signal caused by the vibration is amplified, integrated and differentiated by standard computer-type circuits and compared with the preset limit values. If it exceeds them, a red light glows and the tube is rejected.

The tube is also checked under power for any electrical leakage between elements while being tapped. If leakage exceeds limits, one of several lamps glows, indicating which elements are shorted. An entire lot of the same type tubes can be checked without further resetting, each operation taking about 10 seconds.

High Packaging Densities



Transistor circuitry cast in an epoxy stick for lighter and smaller modules

A CAST INSTRUMENT-STICK which allows transistor circuitry packaging densities as high as 74 percent has been developed by Lind Corp. Trenton, N. J. The stick modules result in a size and weight reduction and are replaceable and individually repairable. With low power circuits it is possible to encapsulate with thermal lag packaging. Sticks strapped together will withstand severe shock and vibration. Simplicity of manufacture permits large time saving in going from prototype breadboard circuits to final package design.

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Flat from DC-4.5 mc, usable to 10 mc. VERT. AMPL.: sens. 25 rms mv/in; input Z 3 megs; direct-coupled & push-pull thruout; K-follower coupling bet. stages; 4-step freq-compensated attenuator up to 1000:1. SWEEP: perfectly linear 10 cps-100 kc (ext. cap. for range to 1 cps); pre-set TV V & H positions (30 & 7875 cps); auto. sync. ampl. & lim. PLUS: direct or cap. coupling; bal. or unbal. inputs; edge-lit engraved lucite graph screen; dimmer; filter; bezel fits std photo equipt. High intensity trace CRT. 0.06 usec rise time. Push-pull hor. ampl., flat to 400 kc, sens. 0.6 rms mv/in. Built-in volt. calib. Z-axis mod. Sawtooth & 60 cps outputs. Astig. control. Retrace blanking. Phasing control.

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#666
Factory-wired $109.95
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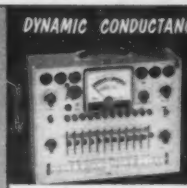

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Elimination of limit switches in power actuators is a result of AiResearch development of superior high temperature motors and resilient non-jamming positive stops.

Limit switches are eliminated by two methods: 1) use of continuous stall high temperature motors, 2) use of high temperature motors with thermal protectors which permit maximum *on* time in the duty cycle.

Additional advantages of AiResearch Limit Switchless Actuators: they are smaller, less complex and the possibility of limit switch failure is eliminated.

Development of Limit Switchless Actuators reflects AiResearch experience in producing more than a million rotary and linear units. Current production includes several hundred actuator types, many with high temperature applications.

Your inquiries are invited.

- **A** *Seat Actuator, CONVAIR B-58*
- **B** *Seat Actuator, LOCKHEED F-104*
- **C** *Rotor Blade Trim Actuator*
- **D** *Elevator Actuator, TEMCO XKDT-1 Target*
- **E** *2-Motor Trim Actuator, REPUBLIC F-105*
- **F** *General Purpose Linear Actuator*
- **G** *Dual Purpose Feel Trim Actuator, AVRO CF-105*
- **H** *Rudder Trim, AVRO CF-105*
- **I** *Duct Shutter Actuator, LOCKHEED ELECTRA*

ENGINEERING REPRESENTATIVES: AIRSUPPLY AND AERO ENGINEERING, OFFICES IN MAJOR CITIES

THE GARRETT CORPORATION

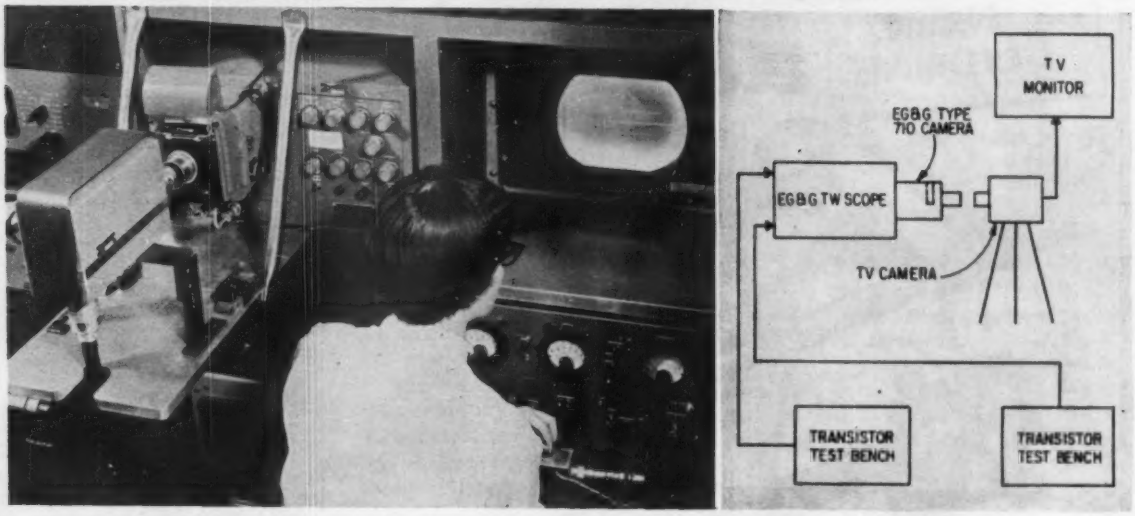
AiResearch Manufacturing Divisions

Los Angeles 45, California • Phoenix, Arizona

Systems, Packages and Components for: AIRCRAFT, MISSILE, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS

CIRCLE 82 READERS SERVICE CARD

Scope, Camera and Tv Test Fast Transistors



Operator observes transistor wave forms on tv monitor. At right is block diagram of test setup

ULTRA-HIGH-SPEED switching transistors are production tested with a traveling wave oscilloscope and closed circuit tv system at the Lansdale Tube Co., division of Philco Corp., Lansdale, Pa.

The transistor rise time is 10 millimicroseconds and its switching potential is about 10v. The oscilloscope, made by Edgerton, Germeshausen and Grier, Inc., Boston, Mass., produces full scale deflection with 10v. Its rise time is 0.1 millimicrosecond, which insures the origination of the observed rise time in the transistor, not the 'scope.

The transistors are connected to the 'scope's deflection system. The tv camera is focused on the screen through a 5X magnifying glass in an EG&G camera. To establish a time scale, an edge-lighted reticle is inserted in the camera at the film plane. The monitor is a 17-inch tv screen.

One system serves 2 test benches. The oscilloscope has a push-pull deflection circuit. Ordinarily, both sides are fed simultaneously in opposite polarity. Lansdale connected each side to a separate test bench.

While one operator reads the rise time of a transistor under test, the second operator prepares the next transistor. Waveforms are displayed in opposite directions, avoiding confusion as to which operator is feeding the signal. Accuracy is not affected.

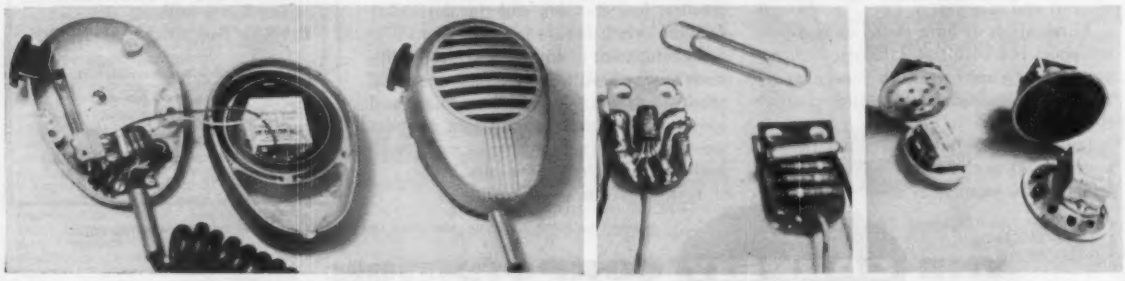
Crystal's Frequency Is Cleanliness Test

By Ernest B. Lewis
E. B. Lewis Co., East Hartford, Conn.

QUARTZ CRYSTAL is a fabulous tool for measuring its own cleanliness. Instruments permit us to measure its resonant frequency within a single cycle. Theoretically, it is possible to detect a layer of dirt a 10-billionth of an inch thick.

For example, using the appropriate formula, we find that a 25 mc

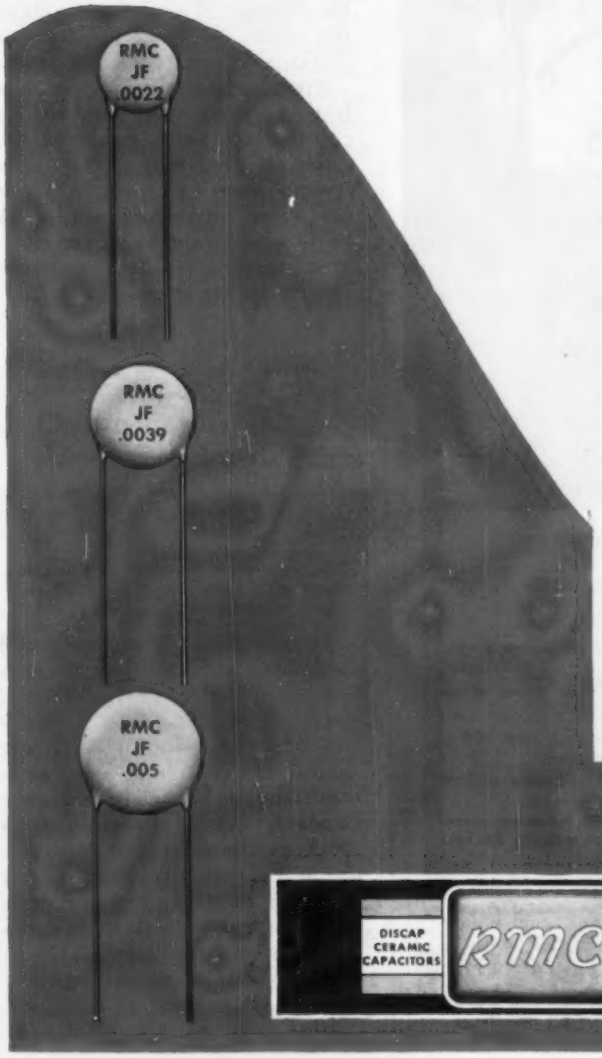
DESIGN TRENDS: Built-in Microphone Preamplifier



Magnetic and dynamic microphones with built-in transistor preamplifiers are gaining favor as a means of improving intelligibility of vehicular communications. Placing the preamp in the mike reduces interference. Microphone at left, designed by Shure Brothers, Evanston, Ill., has its amplifier mounted in cavity below transducer, on screw which holds spring switch. The unmounted amplifier is in the center. At right, are a balanced armature magnetic transducer and a dual dynamic transducer which serves as both microphone and loudspeaker. When the latter is used, pressure on the talk button of the microphone connects in the preamplifier. When the button is released, the terminals for loudspeaker operation take over

FREQUENCY STABILITY

WITH *RMC* DISCAPS



TYPE JF DISCAPS

Type JF DISCAPS are especially designed for applications requiring a ceramic capacitor with superior frequency stability. These DISCAPS extend the available capacity range of the EIA Z5F type capacitors between +10° and +85°C and meet Y5S specifications between −30° and +85°C. Now manufactured in capacities between 150 MMF and 10,000 MMF, Type JF DISCAPS exhibit a change of only ±7.5% between +10° and +85°C.

Write today on your company letterhead for information on RMC DISCAPS.

DISCAP CERAMIC CAPACITORS

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GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.
Two RMC Plants Devoted Exclusively to Ceramic Capacitors
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FEATURES

- Long Life
- Outstanding stability
- High input impedance
- Wide voltage range
- Large easy to read meter with overlap
- High accuracy at any point on the scale
- Light, compact, rugged

MODEL 300-D
PRICE: $235.

SPECIFICATIONS

VOLTAGE RANGE: 1 millivolt to 1000 volts rms, in 6 decade ranges. (.01, .1, 1, 10, 100 and 1,000 volts full scale).

FREQUENCY RANGE: 10 to 250,000 cps.

ACCURACY: 2% throughout voltage and frequency ranges and *at all points on the meter scale.*

INPUT IMPEDANCE: 2 megohms shunted by 15 μμf except 25 μμf on lowest range.

DECIBEL RANGE: −60 to +60 decibels referred to 1 volt.

STABILITY: Less than ½% change with power supply voltage variation from 105 to 125 volts.

SCALES: Logarithmic voltage scale reading from 1 to 10 with 10% overlap at both ends; auxiliary linear scale in decibels from 0 to 20.

AMPLIFIER CHARACTERISTICS: Maximum voltage gain of 60 DB; maximum output 10 volts; output impedance is 300 ohms. Frequency response flat within 1 DB from 10 to 250,000 cps.

POWER SUPPLY: 115/230 volts, 50-420 cps, 35 watts approx.

Write for catalog for complete information.

BALLANTINE LABORATORIES, INC.

100 FANNY ROAD, BOONTON, NEW JERSEY

Group of crystals are immersed in glass beaker in ultrasonic tank

crystal must be 0.00253 inch thick. If a contaminant increases thickness by 0.1 per cent, the crystal's frequency will be reduced by 24,975 cycles, assuming the constant for soil is the same as for the crystal.

This method of checking for contaminants was developed by John Rameika, our chief engineer, to test the efficiency of an ultrasonic cleaning unit installed by Branson Ultrasonic Corp., Stamford, Conn.

First, crystals were cleaned of lapping compound, cleaned by chromic acid and measured for resonant frequency. The same crystals were immersed in a cold tap water ultrasonic bath for 5, 10, 15 seconds, and so on, and measured again after each exposure. The results are shown in Fig. 1.

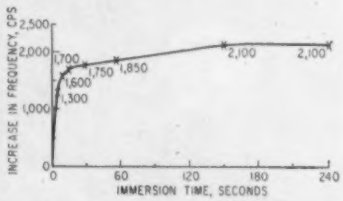
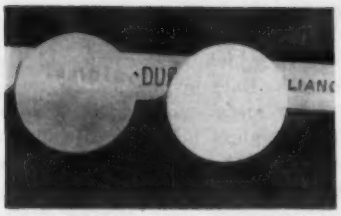


FIG. 1—Effect of ultrasonic cleaning on resonant frequency of 7100 kc BT cut quartz crystal

Crystal frequency was measured using standard government specified oscillators (MIL-C-3098B). Their signal was fed to a Hallicrafter SX-28 receiver and beat against a signal from a temperature stabilized secondary frequency standard, Crystal Research Labs 100-X, monitored against radio station WWV with a Wilcox F-3 fixed frequency receiver. The beat note was measured on a General Radio Interpolation Oscillator 1107-A. Accuracy of these measurements is 1 part in 25 million.

Other tests made included tests



Cleaned crystal (right) appears snow-white compared with uncleaned crystal

of activity and adhesion after silver plating. The findings of the test caused a change in the cleaning procedure. Formerly, after removal of lapping compound, crystals were boiled 10 minutes in chromic acid, boiled up to 1 hour in detergent, rinsed 6 or 7 times and oven-dried.

Now, they are immersed in hot, not boiling acid, rinsed, cleaned of chromic acid traces ultrasonically, rinsed in hot detergent for 10 minutes, rinsed 3 times in hot tap water, rinsed ultrasonically, rinsed 3 times in distilled water and dried.

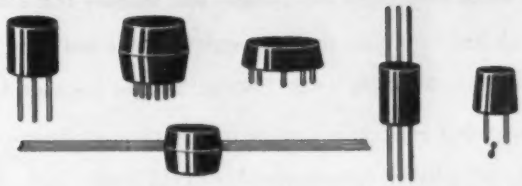
There are more steps, but cleaning time is less. There is less breakage or fumes due to boiling. Up to 300 crystals may be cleaned in a batch without racking since ultrasonic action gets between two flat crystals. Crystals with incipient cracks will be broken by the ultrasonic agitation.

Oscillation and Air Assemble Small Parts

Carbon fusing chuck mates with plate of 118 assembled terminals

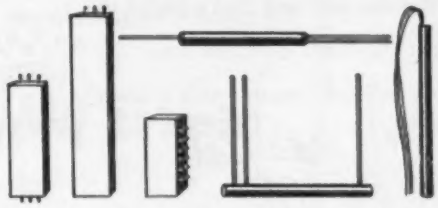
SMALL DISSIMILAR parts of hermetically sealed terminals are batch-assembled on a Freeloader machine. New collector plates adapt the machine to the operation. It was originally developed by Whitso, Inc., Schiller Park, Ill., to load metal inserts and other small

TECHNITROL
ENGINEERING COMPANY



PULSE TRANSFORMERS

Whatever your requirements may be for miniature pulse transformers, Technitrol has a design that will meet your circuit specifications. Commercial or Mil-T-27A low-power transformers with pulse widths ranging from 0.05 to 20 μsec. are available as standard stock components. *Send for Catalog 166*



DELAY LINES

Technitrol manufactures and maintains a complete stock of distributed parameter delay lines in standard package form for plug-in or pigtail mounting. Specially-designed delay lines to meet specific performance characteristics are available on order. *Send for Bulletin 174.*

TEST INSTRUMENTS

Diode Tester: for rapid, accurate checking of semiconductor diodes using dynamic curve. *Send for Bulletin 1001*
Cathode Ray Indicator: a visual indicating device for observing the output of diode testers and transistor curve tracers. *Send for Bulletin 1002*
Variable Pulser: converts any type of signal source up to 5 mc. into standardized pulses of controlled amplitude and duration. *Bulletin 1010*
Variable Frequency Oscillator: supplies a source of frequencies from 100 cps. to 5.6 mc. in 7 bands with continuous tuning over each band. *Send for Bulletin 1011*

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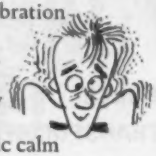
CIRCLE 85 READERS SERVICE CARD

"30 g's to 5000 cycles"

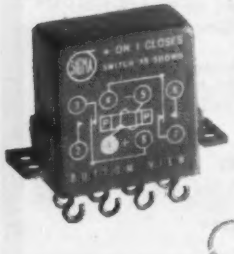
These words from Sigma last Tuesday told industry that a new break-through had been made in the struggle for more and more vibration resistance in relays. What the words *didn't* tell was the poignant, human story of the Sigma project engineer whose life is devoted to vibration — Ralston E. "63 g Rally" (pronounced "rawley") Bates.



Asked to comment on the remarkable vibration immunity of the Series 32, Rally answered with characteristic scientific calm "Boy, we shake 'em till they yell uncle!" Bates' co-workers are quick to point out that the new fame hasn't spoiled the simple pleasures and quiet life of this dedicated man. He still joins the car pool to South Braintree once a month, and a quiet evening at home or a weekend spent boating are all he asks.

Long-time friends like to recall how even as a small boy, Rally was destined for a future of simple harmonic motion. His contributions to the design of Sigma relays in the last 12 years are legion; as he himself puts it, "You can't work for Sigma for a dozen years without making *some* improvements."

SERIES 32
ACTUAL SIZE



Since his last statement no one has been able to reach Mr. Bates for further particulars on the Series 32. Other reliable sources, however, have said that a 32 is: a sub-miniature DPDT relay which needs no standby power (magnetic latching), and only a trifle (50 mw.) at the instant of switching; measures 0.800" x 0.400" x 0.900" maximum; has pins spaced equally on 0.200" centers; is priced low, and is available. Bulletin, which says nothing about Bates, is available on request.

SIGMA

SIGMA INSTRUMENTS, INC.
62 Pearl Street, So. Braintree 85, Massachusetts
AN AFFILIATE OF THE FISHER-PIERCE CO. (Since 1939)

"VISIT SIGMA BOOTHS 1132-1133 AT THE WESCON SHOW"

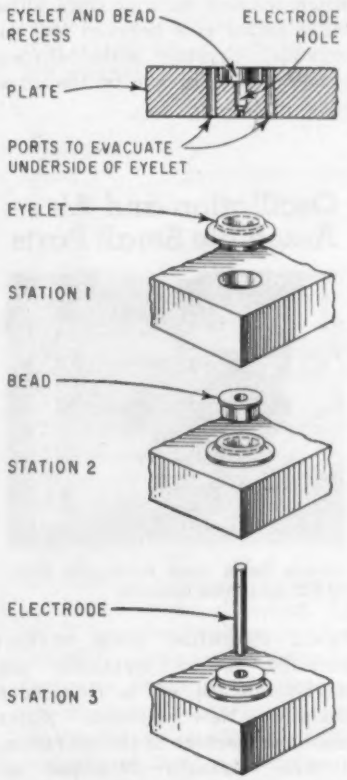
parts into molds.

Each collector plate has 118 orifices which hold completed terminals. Each orifice has a recess for the metal eyelet, a counterbore for the glass bead and a hole for the steel feed-through electrode. The orifices mate with holes in the carbon chuck used in the fusing furnace.

The Freeloader model used has 2 drums, each divided into 2 compartments. Three compartments are bulk-loaded with terminal parts, one kind of part in each compartment. The remaining compartment is not used.

The drums oscillate, bringing the parts over the holes in the orifices. Air, blown into the drums and out the holes, sucks parts in place until all holes are loaded (ELECTRONICS, October 1, 1957).

Maximum production is achieved when one operator handles several collector plates. A plate is clamped on the compartment containing eyelets (station 1), while the compartments containing glass beads



Diagrams show orifices in collector plates and loading sequence

(station 2) and electrodes (station 3) are temporarily sealed with blind plates. The orifices receive the parts in this order.

Other parts handled by loading machine

The machine is put in operation until the plate at station 1 is loaded, in about 1¼ minutes. That plate is moved to station 2 and a new plate goes on station 1. In the third loading cycle, the first plate is at station 3 and collector plates are on all 3 compartments.

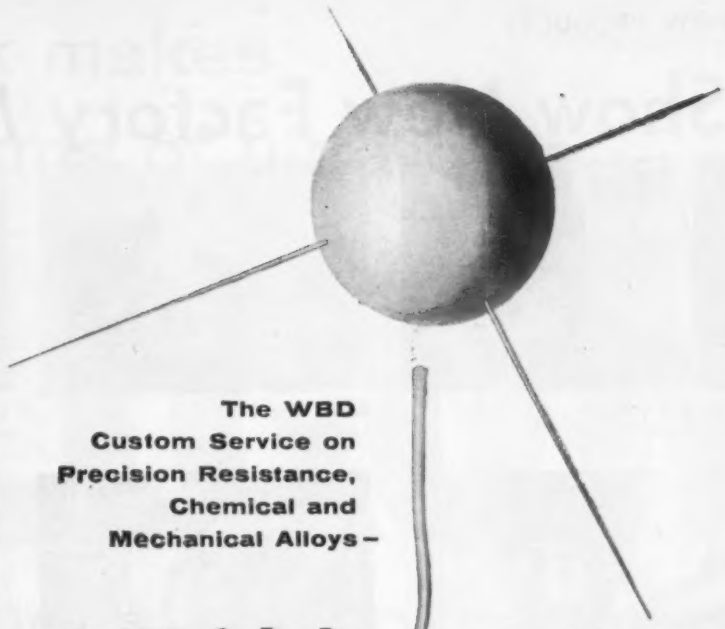
Once the third loading cycle is completed, each cycle produces a collector plate with 118 assembled terminals. The assemblies are transferred from the loaded plate to the fusing chuck by simply placing the chuck on top of the plate and inverting both at once. The chuck is finally placed on the furnace conveyor.

Gallium Rub Prepares Aluminum for Solder

GALLIUM, rubbed on the surface of aluminum or on aluminum-base alloys enables the aluminum to be readily soldered to aluminum or other metals. The process is described in Patent 2,824,365, licensed free by the Atomic Energy Commission, Washington, D. C.

Metallic gallium is rubbed on aluminum which has been heated to 30C, which forms a surface layer of aluminum-gallium alloy. The surface is then wiped and heated to 180 C to 200C. Conventional 60-40 solder may then be used.

The method yields a bond strength equal to that obtained when the aluminum is coated with tin-zinc alloy at 400C. Bond strength may be further improved by coating the aluminum-gallium layer with tin.



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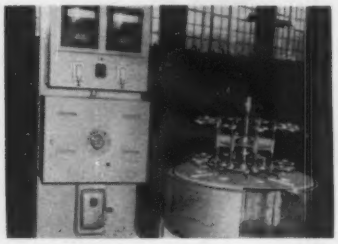
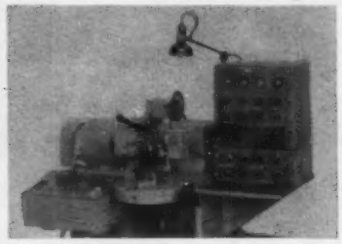
Show New Factory Machines

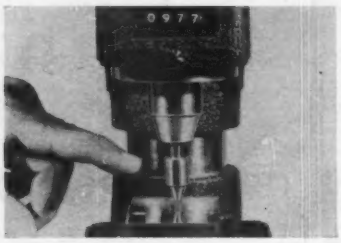


Steiner-Ives Co.
seal annealer

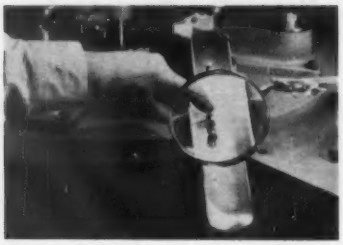


Boesch Mfg. Co.
toroidal winder

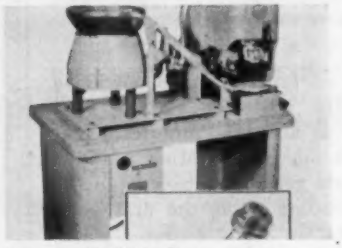
The Robert E. Morris Co.
automatic miller



J. W. Dice Co.
automatic micrometer



Kahle Engineering Co.
sealing machine



Markem Machine Co.
marking machine

As INDUSTRY advances along the automation road an ever increasing number of factory production machines are being placed on the market. Latest announced feature speed and precision.

Steiner-Ives Co., Springfield Rd., Union, N. J., (200) has available a new rotary mount seal annealer (with eight tube holders) for operation at 500 C, to seal mount stem to neck of tube. Oven has total heating length of about 4 ft and cooling length of about 18 in.

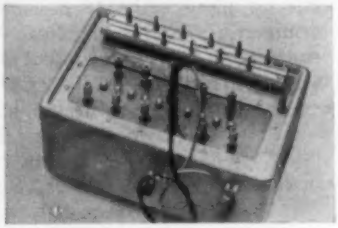
Recently announced by **Boesch Mfg. Co.**, 45 River St., Danbury, Conn., (201) is the TW300 electronically controlled toroidal winder. A control counter provides the means for controlling several new production aid features, such as slow-start slow-stop of the driving motor, automatic winding of segments, and progressive winding.

The Robert E. Morris Co., West Hartford, Conn., (202) with national sales rights to W. H. Nichols Co. milling machines, has just reported model 8SA automatic miller. It is set up for the plunge-cut slicing of germanium into 0.013 in. thick wafers, ± 0.0005 in.

A new model digital readout automatic electronic micrometer is in production at **J. W. Dice Co.**, Englewood, N. J., (203). Featuring adjustable measuring pressure, it can measure fragile or compressible materials, conducting or nonconducting, as well as metallic or hard parts. Direct reading counter reads in decimal fractions of an inch.

Kahle Engineering Co., 1310 Seventh St., N. Bergen, N. J., (204) now makes an 8-position, 8-head, automatic sealing machine for the mass production of glass inner terminal units for electron tubes—a process which heretofore has required skilled hand lathe and glass blowing techniques.

Model 122A marking machine now available at **Markem Machine Co.**, Keene 58, N. H., (205) works automatically. Cylindrical electrical and electronic components with base wire leads may be marked on the top and side at high production rates in a single operation.



Calibrator resistance type

INTERNATIONAL RESISTANCE CO., Hycor Division, 12970 Bradley Ave., Sylmar, Calif. The unit illustrated permits resistance calibrations up to 100 megohms with an accuracy of ± 0.01 percent. It employs a method developed by the Bureau of Standards and enables the transfer of the accuracy of low range standards to the higher ranges with an additional error of transfer of less than ± 0.0001 percent per 2 decades up to 10 megohms and ± 0.01 percent to 100 megohms. Unit consists of 10 calibrated precision resistor steps using encapsulated precision wire wound resistors. Each step is adjusted to ± 0.01 percent of nominal. **Circle 206 on Reader Service Card.**

For more information use READER SERVICE Card

(Continued on page 126)

Only Merck makes all three forms of ultra-pure

SILICON

for semiconductor applications

Merck Polycrystalline Billets—have not been previously melted in quartz, so that no contamination from this source is possible. Merck guarantees that single crystals drawn from these billets will yield minimum resistivities over 50 ohm cm. for n type material, and over 100 ohm cm. for p type material. Merck Silicon Billets give clean melts with no dross.

Merck Polycrystalline Rods—are ready for zone melting as received . . . are ideal for users with floating-zone melting equipment. Merck Polycrystalline Rods (8½ to 10½ inches long and 18 to 20 mm. diameter—smaller diameters on special order) yield more usable material. In float-zone refining one can obtain minimum resistivities of 1000 ohm cm. p type with minimum lifetime of 200 microseconds.

Merck Single Crystal Silicon—offers manufacturers without floating-zone equipment semiconductor Silicon of a quality unobtainable elsewhere. No crucible-drawn crystals can match the reliability of Merck single crystal material in semiconductor devices. Merck Single Crystal Silicon is available with min. resistivity of 1000 ohm cm. p type. Other resistivities ranging from 1.0 ohm cm. p or n type up to 1000 ohm cm. will soon be available.

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For additional information on specific applications and processes, write Merck & Co., Inc., Electronic Chemicals Division, Dept. ES-4, Rahway, N.J.

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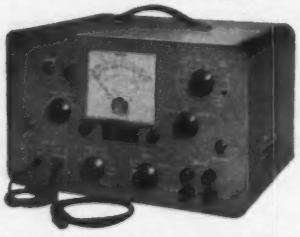
For inert gas filling, 100% mass spectrometer leak testing of any assembly, and every phase of *true* hermetic sealing to meet military or industrial specs, GHS in-plant services are unequalled.

The GHS Megpot®



Quickly, efficiently tests your components, insulation. Features 10 million megohms, 100, 200 or 500V DC, automatic "charge" and safety controls, non-destructive (as high as 5000V AC) high-potential test set with current limiting and automatic shut-off circuit. Portable.

Write for Specific Information... and use the GHS Advisory Services without obligation.

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GENERAL HERMETIC SEALING CORPORATION
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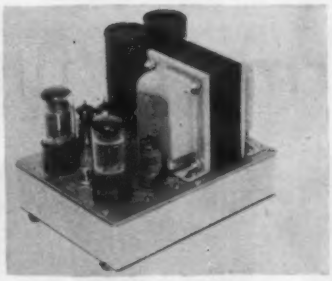
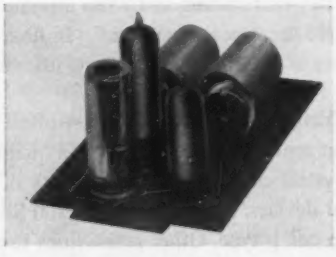
CIRCLE 89 READERS SERVICE CARD



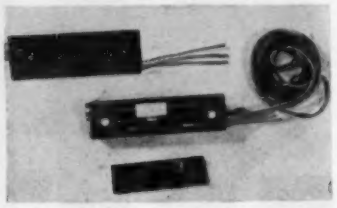
Power Supply modular type

TRANS ELECTRONICS, INC., 7349 Canoga Ave., Canoga Park, Calif., has added another module to its series of unitized power supplies employing silicon rectifiers to achieve small (5¾ in. by 5¼ in. by 7¼ in.) size, and high efficiency. Model RS110 with excellent regulation characteristics (load 0.1 percent; line 0.1 percent) and minimum ripple and noise (3 mv maximum peak to peak) is designed for use in an extensively used voltage range (0-110 v d-c) at 0-100 ma incorporating instant time saving construction for easy substitution and circuit salvage. **Circle 207 on Reader Service Card.**



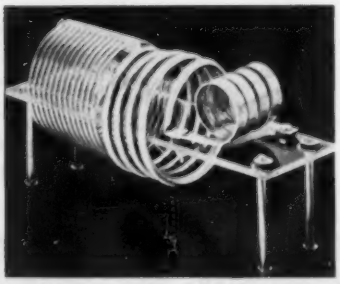
AGC Unit plug-in type

ELECTRO PRECISION CORP., P.O. Box 669, Arkadelphia, Ark. Mounted on a plug-in p-c chassis 3.5 in. by 6.0 in., model DLA-30 automatic gain control unit is designed to maintain constant servo loop gain for reference voltage variations from 2 to 100 v. Primarily useful in applications where the reference voltage is a variable system parameter, where the servo is switched from one loop to another, or where the follow-up potentiometer is part of a bridge circuit, the DLA-30 functions as a variable plate load when used in conjunction with the DLA-10 servo preamplifier. **Circle 208 on Reader Service Card.**



Compact Trimmer rugged, wirewound

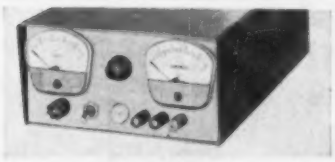
TECHNOLOGY INSTRUMENT CORP., 531 Main St., Acton, Mass. Type RTW miniature high temperature trimmer has a 25 turn lead-screw adjustment. Resistance range is 50 to 100 K ohms. These trimmers are designed for applications in the temperature range from − 55 C to + 225 C. Dual stainless steel contacts on winding and slip ring and precious metal take-off and end tabs contribute to the overall reliability. Compact design makes these trimmers ideal for printed circuit application or stacking of multiple trimmers in a restricted area. **Circle 209 on Reader Service Card.**



Coil Assembly high power

ILLUMITRONIC ENGINEERING, 680 E. Taylor St., Sunnyvale, Calif. Higher efficiency and compactness are features of the two new PiDux coil assemblies. The assemblies are designed for Pi output circuits in commercial and laboratory transmitters. They are available in both 1,000 and 500 w assemblies. The

high frequency coil sections are silver plated for high tank circuit efficiency. **Circle 210 on Reader Service Card.**



V-R Power Supply transistorized

KEPCO LABORATORIES, INC., 131-38 Sanford Ave., Flushing 55, N. Y. Model SC-18-0.5 delivers 0-18 v, 0-0.5 ampere. Regulation for line or load is less than 0.1% or 0.003 v, whichever is greater. Ripple is less than 1 mv rms. Recovery time is less than 50 μsec. Operating ambient temperature is 50 C maximum. Output impedance is less than 0.04 ohm. **Circle 211 on Reader Service Card.**

Voltage Regulator tubeless magnetic

THE SUPERIOR ELECTRIC CO., Bristol, Conn. Stabiline automatic voltage regulator type TMH7101 maintains constant output regardless of line or load changes. It is designed for 115 v, 400 cycle ± 5 percent, single phase duty with a rating of 1 kva. Input voltage range is 95-130 v and output voltage is adjustable from 110 to 120 v. The output voltage accuracy is constant to within a 1.0 v bandwidth for line voltage variations, output load current and load power factor changes. The load power factor range is 0.7 lagging to 1.0. Recovery time is less than 1.0 sec for complete correction of line or load

ACEPOT®

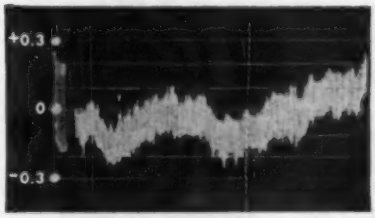
SUB-MINIATURE, PRECISION, WIRE-WOUND

LINEAR POTENTIOMETERS

500 Series ACEPOT actual size

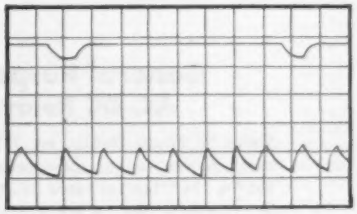
Small pot size — Big pot performance

Only ½" in diameter, the ACEPOT excels in a combination of all around top performance characteristics comparable to larger units. For example, these precision units feature ± 2% resistance tolerance and ± 0.3% independent linearity. Every potentiometer is completely sealed against sand, dust and foreign matter to avoid abrasive action between moving parts. All materials and metals are treated for maximum resistance to salt spray, corrosion, humidity and conform to shock and vibration tests. ACEPOTS are designed and assembled MIL-A-8625A, QQ-M-1512, JAN-T-152, MIL-E-5272A, MIL-R-19A, NAS-710 and MIL-R-19518 (ships).



ACEPOT LINEARITY TEST

Plot of voltage ratio error versus rotation illustrates linearity to better than ± 0.3%.



ACEPOT RESOLUTION TEST

Section of oscillograph trace of electrical resolution shows voltage change for each turn of wire.

ACE offers a wide variety of linear and nonlinear precision, wirewound potentiometers in standard, special and AIA sizes. Custom designs to meet special requirements can be made available on short lead time. Call, write or teletype Dept. F, ACE ELECTRONICS ASSOCIATES, INC., 99 Dover Street, Somerville, Mass., SOmerset 6-5130, TWX SMVL-181.

ACEPOT®
ACETRIM®
ACESET®
ACEOHM®
ACE ELECTRONICS ASSOCIATES, INC.

'DIAMOND H' RELAYS

NEW . . . High Speed Polarized Relays

Fast action with freedom from bounce, plus high sensitivity and consistent operation with low distortion, are provided by small, rugged Series P Polarized Relays. SPDT, with two independent coils, they will handle over 1,000 pulses per second. Various coil resistances up to 5,000 ohms each coil. Contact ratings vary with switching speed but range from 60 MA to 2A with voltages to 120 AC or DC, dependent upon amperages employed.

Aircraft-Missile Series R & S Relays

Miniature, hermetically sealed 4PDT, Series R & S relays provide excellent reliability over their long service life. Electrically and physically interchangeable, the two series differ only in that Series S coils are separately sealed within the sealed cases, with organic matter eliminated from the switch mechanism for greatest reliability in dry circuits. Contacts MA to 10 A.

General Purpose AC, DC Relays

Series W Power Relays are DPDT, double break-double make; measure only 1½" x 1½" x 1⅜", but are rated to 25 A, resistive, at 112-230 V, AC, 1 HP 115 V, AC, 2 HP, 230 V, AC. Socket, panel and sidewall mountings are standard; others available to meet special needs. 12 possible contact arrangements, including sequencing.

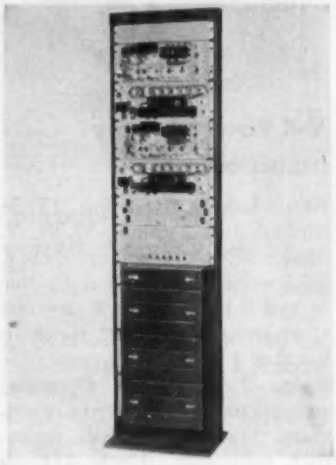
"Diamond H" engineers are prepared to work with you to develop variations on these relays to meet your specific requirements. Tell us your needs . . . by phone or letter.

THE **HART** MANUFACTURING COMPANY

202 Bartholomew Ave., Hartford 1, Conn.

Phone JAckson 5-3491

changes. Waveform distortion is 3.5 percent maximum under all input line and most load conditions, assuming that the input line voltage is sinusoidal and of the nominal frequency for which the unit is designed. **Circle 212 on Reader Service Card.**



Microwave Station 24-channel unit

RADIO CORP., OF AMERICA, Camden, N. J., announces a compact transmitter-receiver unit for microwave radio relay systems that can be inexpensively pole-mounted. It will appear principally to public utilities in communications and remote control operations. The MM-9E provides twenty-four channels for voice communications, facsimile transmissions, teletypewriter and remote control functions. The unit was designed for use with RCA's MV-124 multiplex, or any other ssb frequency-division multiplex equipment. **Circle 213 on Reader Service Card.**

Pulse Sorter transistorized

NAVIGATION COMPUTER CORP., 1621 Snyder Ave., Philadelphia 45, Pa. One of the most common uses

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MEMO:

NEW PRODUCTS RELEASES

TO: ALL MANUFACTURERS

FROM: electronics

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of the company's reversible binary counter is in the digital control of machine tools. In a feedback type system, command pulses are fed to the forward count input and pulses from the machine follow-up movement are fed to the reverse input to compute the lag or error. Although the reversible counting of the unit is completely automatic, the feedback pulses may occur at random or coincident with the command pulses. The pulse sorter 136A is the answer to this problem. It is connected in series with both the forward and reverse inputs to the counter and blanks both pulses, should they occur within 5 μsec of each other. **Circle 214 on Reader Service Card.**

Transformer wide band type

North Hills Electric Co., Inc., Mineola, L.I., N.Y. Type 1210 wide band transformer is announced. Designed for operation over the 100 kc to 100 mc range with minimum insertion loss, these transformers may be used for step-up or step-down. Impedance ratio is 600 ohms: 75 ohms. Applications include antenna matching, receiver and low power transmitter coupling, and use in many circuits where isolation, impedance matching, or step-up are required over a wide band. **Circle 215 on Reader Service Card.**

Frequency Changer all solid state

EMP Electronics Research Laboratories, Inc., 1940 E. Buchanan St., Phoenix, Ariz. Model FC-1 is a 50 va, 400 cps output, 115 v 60 cps input, transistorized frequency changer. It features 4 percent voltage regulation from no load to full load. Frequency sta-

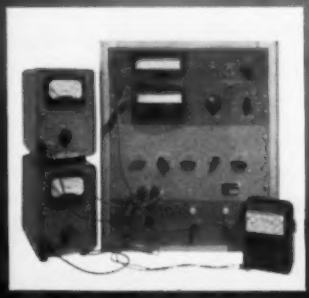
7 benefits for you with trio labs'

BUILD-IN

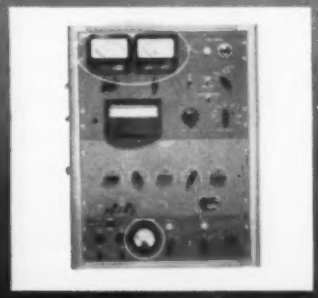
concept

By *designing-in* **trio** miniature panel-mounting instruments into operating and testing equipment, you . . .

- customize both your test set-up and instruments
- save space (average **trio** model is 4" x 4" x 4")
- save time: at-a-glance sequential or continuous monitoring
- save money: exclude unnecessary instrument functions, ranges
- make monitoring foolproof: read "go/no-go" by switching
- improve testing efficiency and system reliability
- increase overall design freedom



BEFORE . . . 3 external instruments were used to measure AC and DC voltages . . . cluttered, tedious, wasteful, subject to error.



AFTER . . . 3 **trio** VTVMs integrally built-in now are always on hand to measure just the parameters you designate.

3 ways you can use Trio Labs' pioneer know-how . . .

1. choose from **trio's** complete line of "standard" models.
2. select a "special" already produced – and you save the engineering time and money that went into it.
3. consult us for design specific to your own needs.

Write for free "how to" Engineering Guide to Dept. F8 Trio Laboratories, Inc., New York. When ordinary instruments are too big or inadequate . . .

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WESCON BOOTH 1909

To the talented engineer and scientist

APL OFFERS GREATER FREEDOM OF ACTIVITY

APL has responsibility for the *technical direction* of much of the guided missile program of the Navy Bureau of Ordnance. As a result staff members participate in assignments of challenging scope that range from basic research to prototype testing of weapons and weapons systems.

A high degree of freedom of action enables APL staff members to give free rein to their talents and ideas. Thus, professional advancement and opportunities to accept program responsibility come rapidly. Promotion is rapid, too, because of our policy of placing professional technical men at all levels of supervision.

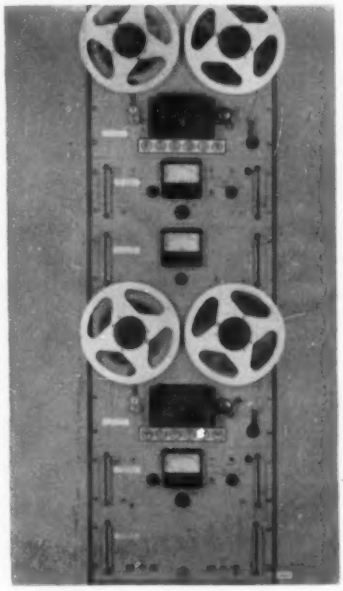
APL's past accomplishments include: the first ramjet engine, the Aerobee high altitude rocket, the supersonic Terrier, Tartar, and Talos missiles. Presently the Laboratory is engaged in solving complex and advanced problems leading to future weapons and weapons systems vital to the national security. Interested engineers and physicists are invited to address inquiries to:

Professional Staff Appointments

The Johns Hopkins University Applied Physics Laboratory

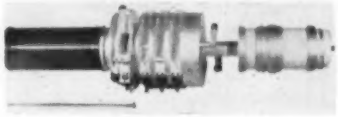
8609 Georgia Avenue, Silver Spring, Maryland

bility is 4 percent from no load to full load. It is a completely static device. **Circle 216 on Reader Service Card.**



Recorder/Reproducer for broadcasting

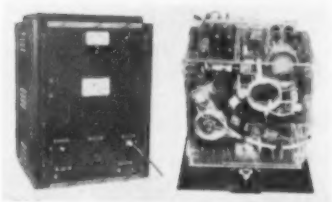
TELECTRO INDUSTRIES CORP., 35-16 37th St., Long Island City 1, N. Y. Model 1238 time delay record-reproducer system records live programs being broadcast and stops at the end of the program. Upon receiving a proper cue signal it replays the program one, two or three hours later. The equipment automatically records, erases and even monitors itself during the entire cycle. Monitoring is accomplished by simultaneously recording a 25 cps signal with the program. Utilizing the fail-safe method, absence of a monitor signal provides positive identification of unit failure in the event of a malfunction. **Circle 217 on Reader Service Card.**



Amplifier Klystron covers 1,700-2,400 mc

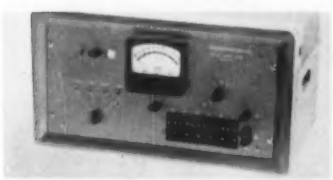
EITEL-MCCULLOUGH, INC., San Bruno, Calif., announces a new

external-cavity power amplifier klystron covering the 1,700 to 2,400 mc range. Designated the 4KM50,000SG, it is rated at 10 kw c-w power output with less than 1 w drive—a power gain of 10,000 times at an efficiency of 35 to 40 percent. It incorporates an Eimac modulating anode which allows simple continuously variable control of power applied to the tube, and which permits shaped-pulse and amplitude modulation as well as c-w operation. These klystrons are now in use in high power tropospheric scatter installation. **Circle 218 on Reader Service Card.**



D-C Power Supply regulated h-v unit

Spellman Television Co., 3029 Webster Ave., New York 67, N. Y. Model LAB-90 is a h-v regulated d-c power supply with voltages continuously variable from 0 to 90 kv. Output current is at 1 ma at 80 kv; 2 ma from 40 kv down. Voltage regulations are better than 1 percent throughout the range. Panel dimensions are: 19 in. wide, 26 in. high and 18 in. deep. It is available complete with HV meter in either positive or negative polarity output. **Circle 219 on Reader Service Card.**



Test Unit for semiconductors

Trans Electronics, Inc., 7349 Canoga Ave., Canoga Park, Calif. Model FT1 (forward current tester) is designed for testing ger-

microwave absorbers by McMillan

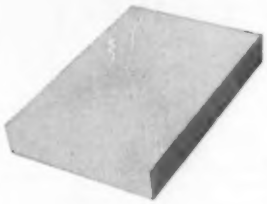
McMillan Industrial Corporation makes various materials for the absorption of microwave energy, for indoor or outdoor use and for ground or airborne applications. Listed below are the three most popular absorbers, their typical applications, specifications and characteristics.

TYPE "T"
THIN — FLEXIBLE

Especially adaptable for airborne applications, the type "T" is an extremely versatile absorber where space and weight limitations are essential. Easily formed, it is impervious to effects of moisture, hydraulic fluids, gasoline etc., when edge sealed.

SPECIFICATIONS

Frequencies:	2500 to 35,000 MC.
Bandwidth:	±3%
Power Reflection Coefficient:	
Perpendicular Polarization	1%
Parallel Polarization	2%
Perpendicular & Parallel Polarization	2%
Power Dissipation:	2 watts/sq. in.
Temperature Range:	—62°F to 172°F
Thickness & Weight:	at 9375 MC., 3/16" thick, 4.7 oz./sq. ft. at 5400 MC., 1/4" thick, 5.7 oz./sq. ft.
Standard Sheet Size:	18" x 36"



TYPE "BL" & "BH"
PERMANENT — LIGHTWEIGHT

Two stable absorbers whose high performance and long life is not affected by moisture, humidity and dust. Type "BL" is fine for walls, ceilings and test panels. Type "BH" is excellent for test room floors and outdoor installations, as its high absorption characteristics are unchanged when it is walked on.

SPECIFICATIONS

Frequency range:	1000 to 35,000 MC.
Power reflection coefficient:	0.4% at 24,000 MC.
(perpendicular and/or parallel	1.0% at 9,400 MC.
polarization)	2.0% at 5,400 MC.
Power dissipation:	2 watts/sq. in.
Temperature range:	(type "BL") —62°F to 155°F
	(type "BH") —62°F to 175°F
Standard block size:	2" or 4" thick, 4' long, 1' wide
Weight:	(type "BL") .5 lbs./sq. ft.
	(type "BH") .7 lbs./sq. ft.

TYPE "BL-48"
BROADBANDED — PERMANENT

Recommended for use in the low frequency range where permanent attenuation characteristics are required, for both indoor and outdoor applications.

SPECIFICATIONS

Frequency range:	40 to 35,000 MC.
Power reflection coefficient:	2½%
(perpendicular and/or parallel polarization)	
Power Dissipation:	2 watts/sq. in.
Size:	Base — 1' x 2'
	Height — 48"
Weight:	5 lbs./sq. ft.
Temperature range:	—62°F to 155°F

Also available — Type "H" Hair Mat Absorbers in thicknesses from 1" to 8" for frequencies from 500 to 35,000 MC

WESCON
Booth 903-904

McMillan

McMILLAN LABORATORY, INCORPORATED
Brownville Avenue • Ipswich, Massachusetts

WE'RE MEETING
THE DEMAND WITH
INCREASED PRODUCTION

now available
for immediate delivery

Waterman

3XP1

RAYONIC CATHODE RAY TUBE

3XP1 IS 33 VDC/INCH—2ND ANODE AT 2000 VOLTS

FOUR TIMES THE SENSITIVITY
FOUR TIMES THE LIGHT OUTPUT
OCCUPIES ½ PANEL SPACE
} AS AGAINST 3" ROUND TUBE

3AHP1

RAYONIC CATHODE RAY TUBE

3AHP1 IS: 30 VOLTS VDC/INCH—2ND ANODE AT 1000 VOLTS

TWO TIMES THE SENSITIVITY
OCCUPIES ½ THE PANEL SPACE
COMPARABLE IN PRICE
} AS AGAINST 3" TUBE

Phosphors Available: P1, P2, P7 and P11

See Us At
WESCON
Booth 1144

MANUFACTURERS OF
PANELSCOPE* PANELPACK* POCKETSCOPE*
PULSESCOPE* RAKSCOPE* SYSTEMAT*
. . . And Other Associated Equipment
*Registered Trademarks

WATERMAN PRODUCTS

WATERMAN PRODUCTS CO., Inc.
PHILADELPHIA 25, PA. • GArfield 6-8600

manium or silicon semiconductors. Output voltage is 0-3 v d-c. Line regulation and load regulation are each better than 10 mv. Ripple and noise are less than 2 mv peak-to-peak. Six telephone-type lever key switches select desired range in metering both voltage and current. Down positions measure current to 3,000 ma. Up positions measure output voltage on 0-3,000 and 0-1,000 mv ranges. **Circle 220 on Reader Service Card.**

Digital Indicator for transducers

DAYTRONIC CORP., 216 S. Main St., Dayton 2, Ohio. Size, motion, force, pressure, stress, strain, and other physical quantities can be measured digitally at reasonable cost using the model 600 digital indicator with available differential transformer transducers. The unit uses the synchro-sweep principle in which a rotary pot, connected in a bridge circuit with the transducer is driven continuously by a synchronous motor at a speed in synchronism with the transducer carrier frequency. **Circle 221 on Reader Service Card.**

R-F Voltmeters highly sensitive

BOONTON ELECTRONICS CORP., 738 Speedwell Ave., Morris Plains, N. J.

Model 91-CA r-f voltmeter is designed to provide extreme sensitivity for voltage measurements from 50 kc to 600 mc. Eight ranges cover from 1 mv full scale to 3 v. A 52-ohm adapter is provided to facilitate high frequency measurements or coaxial systems. Model 91-C is a less expensive version of the 91-CA having seven ranges from 3 mv full scale to 3 v. All other features are the same as the 91-CA. **Circle 222 on Reader Service Card.**

Tachometer
photoelectric type

DYNAC, INC., 395 Page Mill Rd., Palo Alto, Calif. The DY-2504A photoelectric tachometer is used to measure shaft rotational speeds or accumulated turns to very high resolution and accuracy on electronic counters. It features low running torque and inertia, constant output voltage regardless of rotational speed, and up to one-deg resolution. It can be turned in either direction, at speeds from 0 to 10,000 rpm. The d-c response permits you to accurately count and totalize increments of shaft rotation at varying shaft speeds down to zero. It can also be used to measure transient rotational phenomena on an oscilloscope **Circle 223 on Reader Service Card.**

Hollow Spheres
made of ceramic

HASTINGS PLASTICS, INC., 1551 12th St., Santa Monica, Calif. Kanamite is the trade name given to hollow,

NEW

Model 301

AC Microammeter

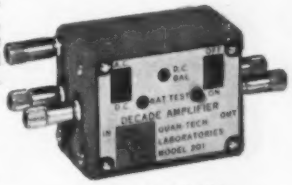
Enables rapid, accurate AC current measurements and observations of wave forms in transistors, magnetic amplifiers, small servo systems, etc. A clamp-on probe and an insertion probe are provided with each instrument.

Sensitivity: 3 ua to 100 ma full scale (300 ua to 100 ma—clamp on probe).
Frequency: ±2% 100 ∿ to 100 KC (±5% 100 ∿ to 100 KC—clamp on probe).
Input impedance: 2 ohms—3 ua to 1 ma; negligible 300 ua to 100 ma.
Price: $290.00

CONCEPTS

DC-Coupled Decade Amplifier

Extremely compact and stable, a completely self-contained miniature amplifier. Its DC response, low noise, and freedom from microphonics make it exceptionally useful with DC oscilloscopes and in sub-sonic as well as conventional applications.



Gain: 10 ±2%, flat within ±2% DC to 100 KC.
Input: 400k ohms and 30 mmf, 20 uv input noise.
Output: 100 ohms, 1 volt P-P max, ½% distortion.
Batteries: Three ZM 9 mercury cells, life 600 hrs.
Price: $85.00

Model 201

IN

Isolation Amplifier

Useful as a Differential or Isolation Amplifier. Supplements voltmeters and oscilloscopes in the measurement of AC voltages whose reference is not at ground potential as in servo systems, motors, magnetic amplifiers etc.

Frequency Response: ±½ db 30 ∿ —100 KC; —3 db at 5 ∿ and 1 MC.
Voltage gain: 1, 0.1, 0.01, 0.001.
Input Impedance: 100k ohm and 50 mmf.
Output: Nominally 20 ohms, 1V. P-P max.
Mercury Battery: Life 600 hours.
Price: $135.00

Model 202

ELECTRONIC

Regulated, Transistorized Power Supplies

Model 104 Power Supply features 0.1% regulation and three metered ranges of voltage and current. Models 101, 102, and 103 (not shown) are compact, lightweight supplies providing voltage metering and 0.25% regulation. Continuous adjustment and overload protection on all models.

Model 101: 0-8 volts DC, 0-2 amps.	**Price** $175.00
Model 102: 0-14 volts DC, 0-1 amp.	**Price** $175.00
Model 103: 0-30 volts DC, 0-½ amp.	**Price** $175.00
Model 104: 0-50 volts DC, 0-1 amp.	**Price** $325.00

Model 104

EQUIPMENT

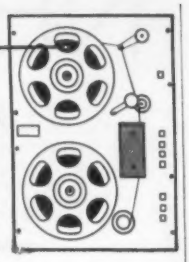
QTL Quantitative Technology

QUAN-TECH LABORATORIES

236 Mt. Kemble Ave., Morristown, New Jersey

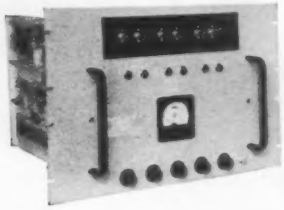
SEE US AT THE WESCON SHOW BOOTH 846

RAPID ACCESS



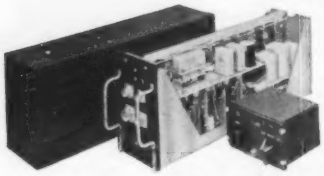
IN ANALOG DATA REDUCTION SYSTEMS

Three companion units by Hycon Eastern provide automatic indexing and high-speed access to selected data in multi-channel magnetic tape instrumentation systems.



For Tape Indexing

DIGITAL TIMING GENERATOR, MODEL 201, generates numerically coded timing signals which are recorded on magnetic tape throughout the data recording periods, providing a precise digital index in terms of elapsed time. The Generator also visually displays the exact time in hours, minutes and seconds as illuminated digits.

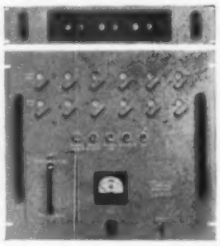


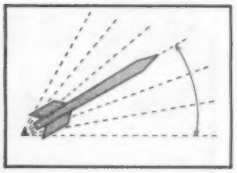
DIGITAL TIMING GENERATOR, MODEL 206A, FOR AIRBORNE APPLICATIONS is a militarized version of Model 201. A Remote Control Box contains Power off-Standby-Operate Switch, the Digital Clock Set, and the Time Display. Completely transistorized, Model 206A includes a binary coded decimal system although other timing formats are available to meet customer requirements. Weighing only 15 pounds, Model 206A is stable to 1 part in 100,000 giving an accuracy of ± 1 second in 1 day's time.

WESCON SHOW
Booth Nos. 1565 & 1566

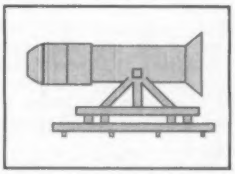
For Tape Search

MAGNETIC TAPE SEARCH UNIT, MODEL 202, operates during data reduction periods. On the basis of time indices recorded on the tape by the Digital Timing Generator, this instrument automatically locates and selects for controlled playback the tape data included between a "sequence start time" and a "sequence end time" specified by panel dial settings. The time index is visually displayed as illuminated digits on a small separate panel which may be remotely located for convenience. Model 202 may be modified to search for timing formats other than those originated by Model 201.

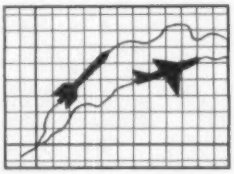




WIND TUNNEL TESTING
Pressure and temperature data of missiles are referenced to angle of attack. Model 201 records on tape a digitized position signal for each new angle of attack.



JET ENGINE TESTING
Digital Timing Generator, Model 201 synchronizes all data receiving equipment. Its output can be piped to multiple test cells and control rooms simultaneously.



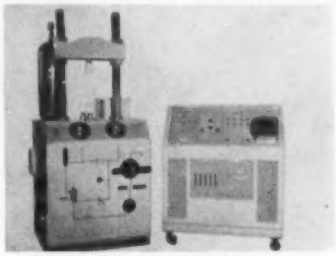
MISSILE AND AIRCRAFT TESTING
Model 206A generates timing signals simultaneously with other flight test data. Model 201 generates a timing code format for synchronizing ground station recordings.

Write for Technical Bulletin TSG

HYCON EASTERN, INC.

75 Cambridge Parkway Dept. A Cambridge 42, Mass.

ceramic spheres which are very adaptable for combining with liquid plastics in order to obtain properties of light weight, dimensional stability, resistance to heat conduction, resistance to high temperatures, and good dielectric performance. One of its almost limitless applications is as a radome filler. **Circle 224 on Reader Service Card.**



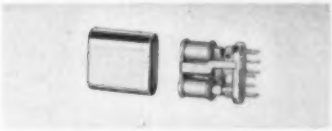
High Rate Tester shows stress, strain

ALLEGANY INSTRUMENT CO., INC., 1091 Wills Mountain, Cumberland, Md. Need for more data on physical properties of materials has led to the development of the model 625B high rate tester. This tensile testing machine consists of separate loading and recording stations for remote testing. It features essentially constant deformation rates, continuously variable from 4 to 8,000 in. per min to permit precisely determining changes in materials characteristics at heretofore unavailable rates of loading. The 625B produces a convenient photographic record calibrated in terms of stress, strain, and time. **Circle 225 on Reader Service Card.**

Servo Motors velocity damped

MECHATROL, a division of Servomechanisms, Inc., 1200 Prospect Ave., Westbury, L. I., N. Y. To provide low cost servo loop damping, a compact new velocity damped

400 cycle servo motor in BuOrd size 11 has been developed. The 1¾ in. long unit employs an adjustable magnetic damper as an integral part of its assembly. Damping is accomplished by the relative motion between a low inertia drag cup fixed to the rotor and an adjustable stationary permanent magnetic field. Adjustment of a screw at the rear of the motor can vary the no load speed of the motor from 5,500 down to 3,900 rpm. Stall torque is 0.60 oz-in. minimum. **Circle 226 on Reader Service Card.**



Sealed Relay microminiature

GUARDIAN ELECTRIC MFG. CO., 1621 W. Walnut St., Chicago 12, Ill. Series 1005 hermetically sealed continuous duty microminiature relay is designed for low-level circuitry. Contact arrangement is 2 pdt. Contacts carry rating of 3 amperes at 125 C per MIL-R-25018 and 2 amperes at 125 C per MIL-R-25018 and MIL-R-5757C; no exceptions. Full details are available on request. **Circle 227 on Reader Service Card.**

Solderable Coating protects components

COLUMBIA TECHNICAL CORP., 61-02 Thirty-First Ave., Woodside 77, N. Y. Type E-9911 protective solderable coating requires no mixing with other materials or thinning of any kind for application. It can be sprayed, dipped or brush applied. Since it is solderable, a component or components may be removed or added without the necessity of a chemical or mechanical removal of the coating. Dielectric strength is 3,000 to 4,000 v/mil in coating thicknesses of 0.00025 in. to 0.0005 in. Humidity cycling conforms to MIL-E-5272A specs. **Circle 228 on Reader Service Card.**

From General Electric . . .

PLAIN TALK ON TANTALYTIC* CAPACITOR AVAILABILITY

It's time for plain talk on the facts of tantalum electrolytic capacitor availability. There is no "availability" problem as far as General Electric is concerned.

Here's why:

- No metal shortage—Stocks of capacitor-grade tantalum have doubled within the past year.
- No production capability shortage—General Electric's production facilities have tripled in the past year.
- No delivery bottlenecks—General Electric's improved manufacturing processes and techniques have virtually eliminated production rescheduling.
- Few military directive priorities—Since the supply of Tantalytic capacitors has met demand, the military requirements can be met without directive priorities.

This is why we say—now and in the future, General Electric will continue to provide Tantalytic capacitors in the types and ratings you want—when you want them.

For specific information on Tantalytic capacitor ratings, prices, deliveries, contact your nearest General Electric Apparatus Sales Office or write to General Electric Co., Section 449-4, Schenectady 5, N. Y.

*Registered trade-mark of General Electric Co.

**Trade-mark of General Electric Co.

SOLID TANTALYTIC CAPACITORS—for transistorized circuit applications—rated up to 60 volts, polar units only—sizes down to 0.125 inches by 0.250 inches.

125C TANTALYTIC CAPACITORS—for aircraft electronic systems — ratings 10–180 mfd, 30 to 100 volts. Sizes ½ to 1⅛ inches in height. Also tubular, double-cased units.

KSR** TANTALYTIC CAPACITORS—for missiles, radar, airborne electronic equipment applications—ratings up to 3500 mfd—three case sizes 1.375, 2, 2.5 inches in height.

85C TANTALYTIC CAPACITORS—for applications requiring high quality but where temperatures are less severe.

GENERAL ELECTRIC

ADVANCED DESIGN
New
SUB-MINIATURE RELAY
HUSKY STYLE 506

for Critical Applications in *Low Level Circuits* and for *General Purpose Use* on Aircraft and Missiles

STYLE 506 RELAYS—designed to meet the requirements of MIL-R-25018 (USAF)—are now in production at Price Electric Corporation. They are available in two types—for low level operation, and standard design for general purpose use. Both are hermetically sealed.

COIL DATA: Standard DC voltage is 26.5 VDC with DC coil resistance of 400 ohms ± 10% at 25C.

DUTY: Continuous

CONTACTS: Contact arrangement is DPDT. Standard contacts are suitable for low level circuits or general purpose use. Normal rating is 2 amperes, non-inductive at 26.5 VDC.

LIFE EXPECTANCY: Mechanical life in excess of 20,000,000 cycles. Exceeds 750,000 cycles at 2 amperes non-inductive.

CONSTRUCTION:

Low-Level Circuits
—special design permits isolation of all organic materials from the contact chamber. Each relay is assembled under "ideal" conditions in air-conditioned, pressurized room.

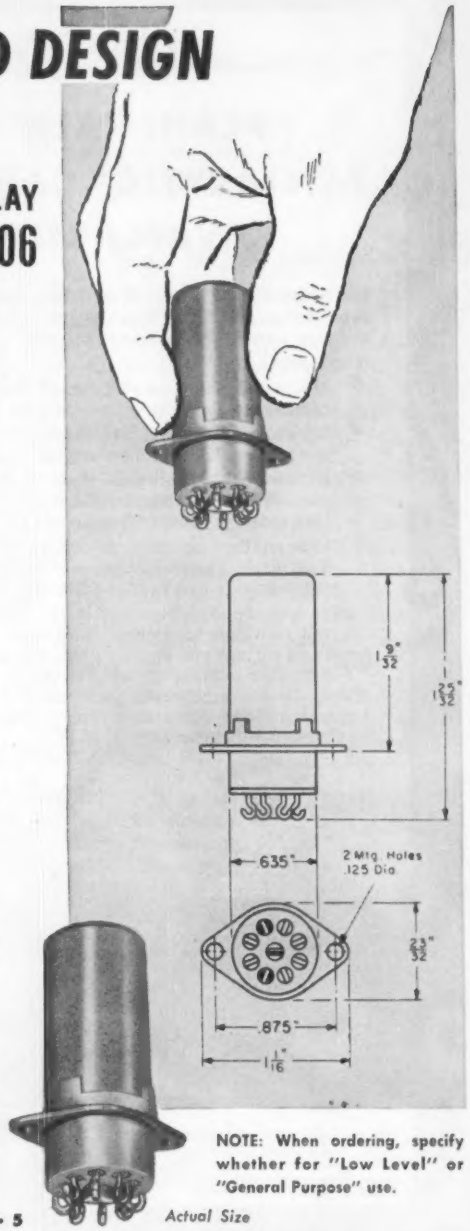
General Purpose
—standard design, without the isolation feature.

New balanced armature design gives high immunity to shock, vibration, and acceleration.

Two types of terminals available —solder (illustrated) or plug.

WEIGHT: 1.5 ounces

Write for Bulletin No. 5



NOTE: When ordering, specify whether for "Low Level" or "General Purpose" use.

Actual Size

Price Electric CORPORATION
FREDERICK, MARYLAND

PRICE ELECTRIC CORP., FREDERICK, MD.
HUSKY RELAYS & CONTROLS ®

Literature of

MATERIALS

Plastic Laminates. Taylor Fibre Co., Norristown, Pa. Copper-clad plastic laminates for electronic printed circuits are the subject of a new technical bulletin. It describes the laminates as a combination of high-purity rolled copper on superior plastic base materials. **Circle 229 on Reader Service Card.**

COMPONENTS

Filter Capacitors. General Electric Co., Schenectady 5, N. Y. Bulletin GEA-6819, 6 pages, gives detailed information on the description, operation and application of filter capacitors designed for computer circuits where high reliability and long operating life are desired. **Circle 230 on Reader Service Cord.**

Magnetic Modulators. General Magnetics Inc., 135 Bloomfield Ave., Bloomfield, N. J. A four-page folder illustrates and describes a line of miniaturized Mag Mod magnetic modulators. Electrical and mechanical specifications are included. **Circle 231 on Reader Service Card.**

Motor Catalog. Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio. A 10-page catalog describes four basic models and sizes of miniature d-c p-m and wound field motors, associated and often interchangeable spur and planetary gear boxes, governors, and radio noise filter. **Circle 232 on Reader Service Card.**

Permanent Magnets. The Indiana Steel Products Co., Valparaiso, Ind. Catalog PR-19 lists over 70 cast Alnico V magnets and over 30 sintered Alnico II magnets, in addition to demagnetizers and a complete line of electro and permanent magnetizers. **Circle 233 on Reader Service Card.**

Silicon Rectifiers. Transitron Electronic Corp., 168 Albion St.,

the Week

Wakefield, Mass. Data sheets on three new families of silicon rectifiers are now available. They cover high voltage types, subminiature group, and 50 ampere rectifiers. **Circle 234 on Reader Service Card.**

EQUIPMENT

D-C Power Supplies. Gow-Mac Instrument Co., 100 Kings Road, Madison, N. J. A single-sheet bulletin covers the series 9293 d-c power supplies designed for operating thermal conductivity cells for gas chromatography or other instrumental gas analysis. **Circle 235 on Reader Service Card.**

Receiver Recorder & Controller. Bailey Meter Co., 1050 Ivanhoe Road, Cleveland 10, Ohio. Sixteen-page product specification E12-5 contains details of newly developed plug-in components for the recorder. In all, 12 types of receivers, controllers, retransmitters, and direct measuring devices from which the recorder may be custom-built are described. **Circle 236 on Reader Service Card.**

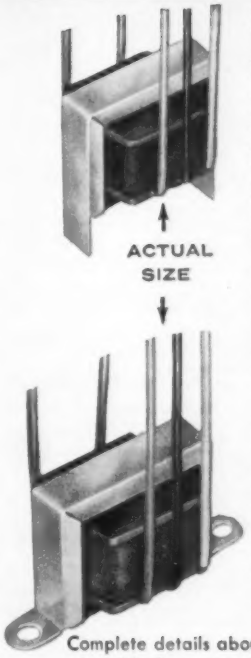
FACILITIES

Facility Brochure. Levinthal Electronic Products, Inc., 760 Stanford Industrial Park, Palo Alto, Calif. An eight-page folder presents the story of personnel, research, development and manufacturing activities; and product activities at the company. **Circle 237 on Reader Service Card.**

Servo Construction. Gap Instrument Corp., 33 S. Grove St., Freeport, L. I., N. Y. Producing limited quantities of servo computing units and gear trains is very expensive in terms of dollars and elapsed time. Bulletin ICS 165 discusses the company's "Instrument Construction System" by means of which the elapsed time to produce a satisfactory unit was reduced from months to days. **Circle 238 on Reader Service Card.**

See your CHICAGO STANDARD distributor for your widest choice of STOCK transformers

90 NEW STANCOR Transistor Transformers IN STOCK



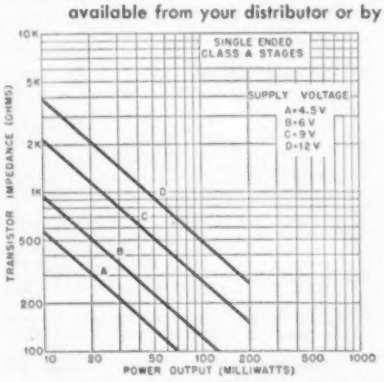
150 MW GROUP; 2½" x 1⅜" x ⅜"; wt. 0.65 oz.

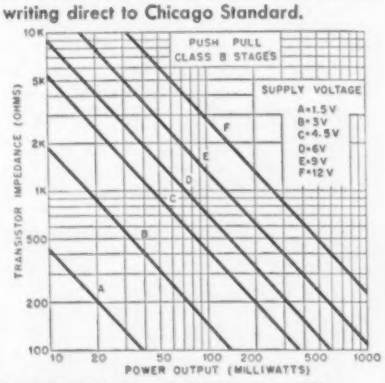
Stancor Part No.	Application	Turns Ratio Pri. to Sec.	Impedance in Ohms Pri.	Sec.
TA-18	Input	1.00:45.5	30 C.T.	50,000
TA-19	Interstage	3.08:1	100 C.T.	10 C.T.
TA-20	Output	5.22:1	350 C.T.	4, 12
TA-21	Output	5.53:1	500 C.T.	4, 8, 16
TA-22	Interstage	3.16:1	500 C.T.	50
TA-23	Output	5.65:1	600 C.T.	4, 8, 16
TA-24	Interstage	10.0:1	500 C.T.	50,000
TA-25	Output	6.75:1	825 C.T.	4, 8, 16
TA-26	Output	9.80:1	1,250	4, 12
TA-27	Interstage	4.08:1	1,200	20,000 C.T.
TA-28	Interstage	1.65:1	1,500	500 C.T.
TA-29	Output	11.8:1	2,500	4, 16
TA-30	Interstage	1.00:1.22	5,000 C.T.	7,500 C.T.
TA-31	Interstage	1.00:1.41	5,000 C.T.	10,000 C.T.
TA-32	Interstage	1.00:4	5,000 C.T.	80,000 C.T.
TA-33	Output	24.6:1	10,000 C.T.	4, 8, 16
TA-34	Interstage	14.0:1	10,000	200 C.T.
TA-35	Interstage	2.24:1	10,000	2,000 C.T.
TA-36	Interstage	1.83:1	10,000	3,000 C.T.
TA-37	Output	5.55:1	400 C.T.	11
TA-38	Interstage	3.44:1	500 C.T.	150 C.T.

300 MW GROUP; 1⅜" x 1⅝" x ¾"; wt. 1.2 oz.

TA-39	Output	3.08:1	100 C.T.	4, 8, 16
TA-40	Output	3.27:1	160	4, 8, 16
TA-41	Output	5.00:1	400 C.T.	4, 8, 16
TA-42	Output	5.60:1	500 C.T.	4, 8, 16
TA-43	Output	6.63:1	700 C.T.	4, 8, 16
TA-44	Output	12.5:1	2,500	4, 8, 16
TA-45	Output	13.7:1	3,000	4, 8, 16
TA-46	Interstage	8.17:1	100,000	1,500 C.T.
TA-47	Input	1.00:14.1	1,000 C.T.	200,000 C.T.

Complete details about these new units are available in STANCOR Bulletin 546, available from your distributor or by writing direct to Chicago Standard.





CHICAGO STANDARD TRANSFORMER CORPORATION

3502 ADDISON STREET • CHICAGO 18, ILLINOIS

Export Sales: Roburn Agencies, Inc., 431 Greenwich St., New York 13 N.Y.

WESCON Program and Show Guide

IT'S LESS THAN three weeks away—the 1958 Western Electronic Show and Convention—and the outlook's exciting, promising. From Aug. 19 through 22, L. A.'s Ambassador Hotel and Pan Pacific Auditorium will play host to an estimated 30,000 WESCON conventioneers, predicts Walter E. Peterson, convention director (picture).

The visitors will be offered 42 technical sessions and 210 papers. Four circus-type tents will be required to supplement Pan Pacific's huge display area. Nine hundred exhibit booths will be manned by personnel from 700 different companies.

According to technical program chairman R. C. Hansen, trend of papers is more than ever toward specialties—antennas, microwave tubes, transistors, components, etc. Hansen reports better-than-usual talks are indicated by increased availability of visual aids and other facilities, and by use of a special booklet on presenting WESCON papers. The booklet was prepared by members of IRE's professional group on engineering writing and speech.

Two special technical sessions are scheduled for Aug. 20—"Biological Measurement Problems" and an invited-paper session on "Industry Looks at Fusion Power".

For the first time, all WESCON displays featuring electronic production materials and equipment will be housed together in one pavilion.

The full program follows:

1-Tuesday, August 19
9:30 a.m. to Noon—Embassy Room
COMPUTER APPLICATIONS

"Data Preparation for Numerical Control of Machine Tools" by H. D. Huskey and D. E. Trumbo, Bendix.

"A Library of Blip Samples for Use in the Realistic Simulation and Evaluation of Automatic Radar Data Processing Systems" by C. M. Walter and H. M. Willett, USAF.

"GCA by Automatic-Voice Data Link" by J. J. Fling and M. H. Notham, Gilfillan.

"A Computer Simulation Chain for Research on Picture Coding" by R. E. Graham and J. L. Kelly, Jr., Bell Labs.

2-Tuesday, August 19
9:30 a.m. to Noon—Sunset Room
RELIABILITY I

"Design Techniques for Upgrading the Reliability of Weapons Systems During Flight Readiness Checkout" by M. A. Patterson, Radioplane.

"Reliability and Engineering Colleges" by C. A. Krohn, Motorola.

"The Confidence that Can be Placed on Various Reliability Tests" by C. Ryerson, RCA.

"Optimum Design for Reliability—The Group Redundancy Approach" by J. H. S. Chin, Sperry Gyroscope.

"Integrating Reliability Considerations Into Systems Analysis" by J. B. Heyne, Hughes Aircraft.

3-Tuesday, August 19
9:30 a.m. to Noon—Boulevard Room
TELEMETRY

"Theoretical Data Acquisition Analysis and Practical Appraisal of Existing Airborne Systems" by B. M. Gordon and R. D. Jorup, Epsco, Inc.

"A Compatible PCM/FM/System" by P. E. Bennewitz and H. B. Barling, Gulton Inc.

"A PAM/PDM Decommutator" by E. D. Heberling and J. M. Sacks, U.S.N.O.L.

"Transistor Airborne PDM Systems" by D. A. Williams, Jr., Bendix.

"High Acceleration Telemetering" by T. D. Horning, Bendix.

4-Tuesday, August 19
9:30 a.m. to Noon—Ambassador Ballroom
INFORMATION THEORY

"The Prediction of Derivatives of Polynomial Signals in Stationary Additive Noise" by I. Kanter, RCA.

"Predictive Quantizing of Television Signals" by R. E. Graham, Bell Labs.

"Optimum Linear Estimation as the Limit of Sampled Data Estimates" by P. Swerling, Rand Corp.

"Random Function Probability Distribution after a Nonlinear Filter" by G. O. Young, Hughes Aircraft.

"Statistical Invariance of Noise in Sampled-Data Systems" by S. A. Zadoff, Sperry Gyroscope.

5-Tuesday, August 19
9:30 a.m. to Noon—Venetian Room
MICROWAVE THEORY AND TECHNIQUES I

"Mode Conversion Filters" by E. A. Marcatili, Bell Labs.

"Properties of the H-guide for Microwave and Millimeter Waves" by F. J. Tischer, Ohio State U.

"The Effects of Mode Conversion in Long Circular Waveguide" by W. D. Warters and H. E. Rowe, Bell Labs.

"A New Class of Artificial Dielectrics" by Ming-Kuei Hu and D. K. Cheng, U. of Syracuse.

"A Frequency Measuring Technique Using Paramagnetic Resonance Phenomena in the X-Band Region" by P. A. Crandell, Sylvania.

6-Tuesday, August 19
2:00 to 4:30 p.m.—Embassy Room
COMPUTER DEVICES

"Achieving Maximum Pulse Packing Densities and Transfer Rates" by B. W. Thompson, Ampex.

"An Emitter Follower Coupled High Speed Binary Counter" by I. Horn, Burroughs.

"Coincident Current Applications of Ferrite Apertured Plates" by W. G. Rumble, C. S. Warren, RCA.

"Information Storage for Microspace" by S. P. Newberry, GE.

7-Tuesday, August 19
2:00 to 4:30 p.m.—Sunset Room
RELIABILITY II

Panel Discussion: "Contract Implications of Military Electronics Reliability Requirements"

J. Allen, Ramo-Wooldridge. H. Powell, Ramo-Wooldridge. L. Arndt, Hoffman Electronics. J. S. Lambert, U.S.A.F.

8-Tuesday, August 19
2:00 to 4:30 p.m.—Boulevard Room
AIRBORNE ELECTRONIC DEVICES

"Broadband Radio Interference Generated by Airborne Electronic Devices Utilizing Diode Rectifiers" by J. C. Senn, Convair.

"Compact L Band RF Unit for Air Traffic Control Transponder" by R. Skar, Collins.

"A Precision Digital Data Acquisition System for Instrumentation Radars" by R. Snyder, Electronic Engineering Co.

"Earth's Rate Directional Reference" by Norman Feldman, GE.

"Digital Computer System for Terminal Area Air Traffic Control" by E. L. Braun and A. S. Gianopolus, Litton.

"A Modern Approach and Landing System" by B. Cutler, Gilfillan.

9-Tuesday, August 19
2:00 to 4:30 p.m.—Ballroom
CIRCUIT ANALYSIS AND DESIGN

"On Topological Synthesis" by M. E. Van Valkenburg, U. of Illinois.

"Predistorted Filter Design with a Digital Computer" by P. R. Geffe, Audio Development Co.

"The Design of Two-Section Symmetrical Zobel Filters for Tchebycheff Insertion Loss" by W. N. Tuttle, GE.

"Modern Network Theory Design of Single Sideband Crystal Filters" by M. Dishal, FTL.

"Transmission through a Linear Network Containing a Periodically Operated Switch" by C. A. Desoer, U. of Calif.

10-Tuesday, August 19
2:00 to 4:30 p.m.—Venetian Room
MICROWAVE THEORY AND TECHNIQUES II

"The Power Handling Capacity of Slab Lines" by G. Radovannis, Sperry Gyroscope.

"RF Circuits for a Voltage-Tunable Magnetron" by W. J. Gemulla, Sylvania.

"An S-Band Two-Phase Demodulator" by R. B. Wilds, Sylvania.

"Some Notes on Strip Transmission Line and Waveguide Multiplexers" by D. Alstadter and E. O. Houseman, Jr., Melpar.

"On the Solution of Some Microwave Problems by an Analog Computer" by D. M. Byck, EAI Computation Center, and A. Norris, Varian.

11-Wednesday, August 20
9:30 a.m. to Noon—Embassy Room
PARAMETRIC AMPLIFIERS AND MASERS

"Modified Semi-Static Ferrite Amplifiers" by A. D. Berk, L. Kleinman, C. E. Nelson, Hughes Aircraft.

"Parametric Electron Beam Amplifiers" by A. Ashkin, T. J. Bridges, W. H. Louisell and C. F. Quate, Bell Labs.

"A Parametric Amplifier Using Lower-Frequency Pumping" by K. K. N. Chang and S. Bloom, RCA.

"Solid State Maser Systems" by R. H. Kingston, S. H. Autler, A. L. McWhorter and J. W. Meyer, Lincoln Labs.

"Slow-Wave Structures for Unilateral Solid-State Maser Amplifiers" by R. W. DeGrasse, Bell Labs.

12-Wednesday, August 20
9:30 a.m. to Noon—Sunset Room
MODERN MANAGEMENT PROBLEMS

"Minimizing Employee Losses When R and D Operations Relocate" by R. F. Lander, Electronic Engineering Co.

"The Role of Industry in Science and Engineering Education" by J. Cryden, Hughes Aircraft.

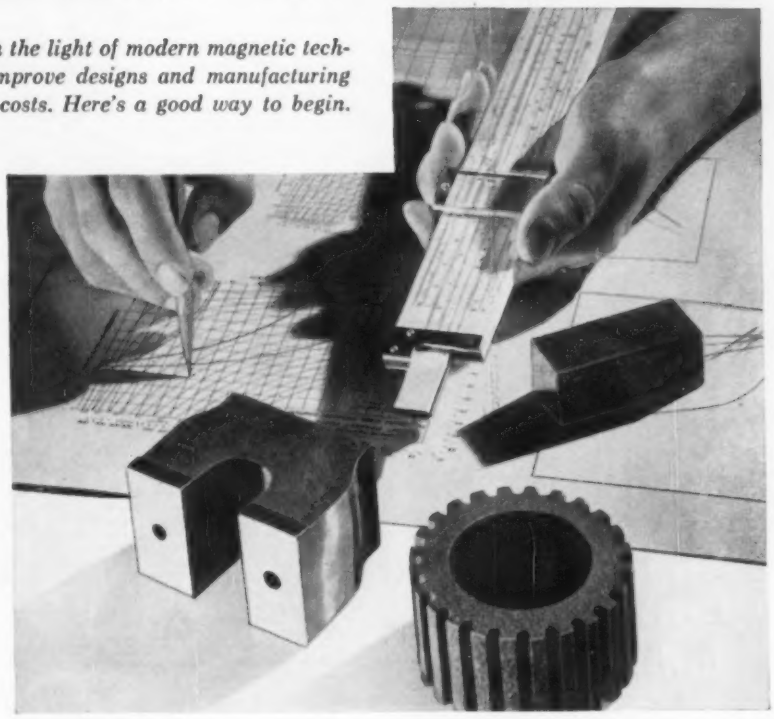
"The Sales Engineer—Human 'Catalyst' of the Electronic Industry" by H. A. Young, Packard-Bell.

"Project Direction in the Development of Avionics Systems" by C. J. Godwin, GE.

"Does the Present Cost-Plus-Fixed Fee Contract Give the Government the Best Deal" by B. Dempster, Electronic Engineering Co.

How Magnet Specialists Can Help Improve Your Product, Cut Design and Production Costs

A close look at your product in the light of modern magnetic technology may reveal ways to improve designs and manufacturing methods with resulting lower costs. Here's a good way to begin.



STUDY THE MAGNETS YOU'RE USING

If your product now employs a permanent magnet, review these considerations:

1. Is the magnet right for the job?
2. Would a larger or smaller magnet improve the design, permit larger physical tolerances, etc?

Example: A manufacturer was using Alnico V magnets in a high-quality intercom unit. Magnetic experts studied the design and found that 83% of the energy of the magnet was nullified in actual operation of the unit. Equivalent results could be obtained with a smaller Alnico magnet or lower cost magnetic materials.

3. Are all close tolerances in the design essential to the performance of the product?

Example: A radar manufacturer — to meet required tolerances—specified an I.D. grind on a permanent magnet used in conjunction with a magnetron assembly. Cost of the magnet was $2.26. Study showed that the I.D. grind was not necessary, and the new magnet price is 81.7¢ each.

4. Would a different magnet material perform more efficiently in this application?
5. Can the design of the magnet itself be modified for greater efficiency, lower cost?

Example: A manufacturer of small electric motors used two Alnico V magnets and two pole pieces in a motor assembly. These four elements have been eliminated in a design that uses one Indox ring magnet — a multiple saving in material, parts and labor.

TOOLING WITH MAGNETS

Literally thousands of manufacturers have cut factory costs with permanent magnets in tooling, processing, material handling and production devices. A partial list of the most common applications will indicate the wide range of jobs a permanent magnet can do effectively and at low cost.

PARTS CONVEYOR
Magnets eliminate clamps and hooks, simplify loading and removal of parts.

CHIP RETRIEVER
Collects chips and other iron particles from coolant, lubricant, etc.

PIPE ROLL
Handles ferrous pipe and tubing at high speed without slippage.

SHEET FANNER
"Fans" sheet steel in stacks to simplify pickup and handling.

FLOOR SWEEPER
Picks up iron scrap, tools, etc. from plant floors, drives and parking lots.

TOOL HOLDER
Keeps tools handy and orderly, speeds work.

SEPARATORS
Magnetic pulleys, plates or drums remove tramp iron from non-ferrous materials in every industry.

RESEARCH AND DEVELOPMENT

Magnetics is a highly specialized science. Too often, competent engineers who are without the required testing facilities and experience will spend months studying a magnetic circuit for a proposed product, finalizing a design that could have been completed in a few weeks with the help of specialists.

Nobody knows magnetics like Indiana Steel Products . . . and Indiana makes all kinds of magnet materials, can recommend exactly the *right* magnet for your specific application. You are invited to consult with our engineers and scientists on any problem involving permanent magnets. Write today for new free catalog, "Cast and Sintered Alnico Permanent Magnets." Ask for Catalog No. 19-A8.

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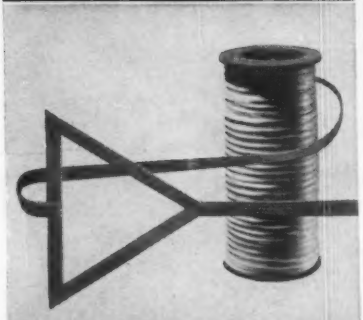

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CIRCLE 103 READERS SERVICE CARD

13-Wednesday, August 20
9:30 a.m. to Noon—Boulevard Room

INSTRUMENT TOOLS

"Millimicrosecond Kerr Cell Camera Shutter" by A. M. Zarem, F. R. Marshall, S. M. Hauser, Electro-Optical Systems.

"A Precision Delayed Pulse Generator as a Variable Time Interval Standard" by D. Hartke, M. Willrodt, and D. Broderick, Hewlett-Packard Co.

"Development of a Transistorized Voltage Controllable Frequency Source" by W. B. Sander and W. E. Wilke, Glifillan.

"Broadband Stabilized Microwave Generators" by J. Hule and C. Elsaman, Stromberg-Carlson.

"Operational Feedback and Data Processing Amplifiers" by S. Sem-Sandberg and R. A. Smith, Consolidated Electrodynamics.

"Broadband Waveguide Bolometer Mounts" by L. I. Kent, Narda.

14-Wednesday, August 20
9:30 a.m. to Noon—Ballroom

CIRCUIT DESIGN

"Graphical Interpretations for Frequency Transformation" by John L. Stewart, USC.

"Optimum Synthesis of RC Ladder Networks" by A. Paige and E. S. Kuh, U. of Calif.

"A New Design Method for Coupling Networks with Applications to Broadband Transistor Amplifiers and Antenna Matching" by P. A. Ligomenides, Stanford U.

"Some Developmental Techniques Concerning Distributed Amplifiers and Virtual Delay Lines" by W. J. Judge, DuMont.

"The Synthesis of Multi-Channel Amplifiers" by B. F. Barton, U. of Michigan.

15-Wednesday, August 20
9:30 a.m. to Noon—Venetian Room

AUDIO

"Experiments with Speech Using Digital Computer Simulation" by E. E. David, Jr., M. V. Mathews and H. S. McDonald, Bell Labs.

"A Survey of Speech Bandwidth Compression Techniques" by S. J. Campanella, Melpar.

"The Four-Track Stereotape Magazine for Home Hi-Fi" by R. J. Tinkham, Ampex Corp.

"A Versatile Compressor-Limiter Audio Amplifier for Studio Use" by E. W. Templin, Westrex Corp.

"Audio Characteristics of Piano Tones" by J. P. Quitter, Baldwin Piano.

16-Wednesday, August 20
2:00 to 4:30 p.m.—Embassy Room

INDUSTRY LOOKS AT FUSION POWER

"Electrical Power Problems in Fusion Research" by H. Hurwitz, GE.

"Spectroscopy Aspects of High-temperature Fusion Research" by S. Cunningham, General Atomics Corp.

"Ultra-high Vacuum Research in Support of the Thermonuclear Fusion Power Program" by W. Lange, Westinghouse.

17-Wednesday, August 20
2:00 to 4:30 p.m.—Sunset Room

TRANSISTOR CIRCUITS

"A Wide-Range Junction Transistor Audio Oscillator" by M. A. Melehy, Michigan State U.

"Comparisons Between Multiple and Single Loop Transistor Feedback Amplifiers" by E. M. Davis, Stanford U.

"The Root Locus Design of Transistor Feedbacks Amplifiers" by D. O. Pederson and M. S. Ghausi, U. of Calif.

"Techniques for Stabilizing All-Transistor DC Amplifiers" by M. Klein, Cohu Electronics.

"Squared Input Stages for low Level Transistor Amplifiers" by K. Hinrichs and B. Weekes, Beckman Instruments.

18-Wednesday, August 20
2:00 to 4:30 p.m.—Boulevard Room

AUTOMATIC CONTROL

"Compensation of Multi-Loop Control Systems" by D. Lebell and M. Mandell, Gardena, Calif.

"Optimization of Compensation for Cascaded Actuators in a Common Feedback Loop" by G. S. A. and E. F. Osborne, Westinghouse.

"Some Simplifying Additions to Basic Sampled-Data Theory" by C. O. Carlson, National Cash Register.

"Contributions to the Analysis of Non-linear Feedback Control Systems" by S. L. Mikhail, U. of Calif.

"Enhanced Real Time Data Accuracy for Instrumentation Radars by Use of Digital Hydraulic Servos" by R. P. Cheetham and W. A. Mulle, RCA.

19-Wednesday, August 20
2:00 to 4:30 p.m.—Ballroom

INSTRUMENT SYSTEMS

"Space and High Vacuum" by J. R. Hafstrom and G. C. McFarland, Scientific Engineering.

"Electronic Measurements of Missile Trajectories" by G. O. Perkins, WSPG.

"Drone Tracking System with Lightweight Airborne Package" by E. J. Walcek, Radioplane.

"Automatic Telemetering Meteorological Observation Station" by M. H. Wittmeyer, P. Boulay and B. I. Florey, V. R. La Torre, U. of Arizona.

"An Airborne Digital Tape Recorder" by S. Cohen and A. T. Arcand, GPL.

"An Electronic Framing Camera for Millimicrosecond Photography" by G. L. Clark, Space Technology Labs.

20-Wednesday, August 20
2:00 to 4:30 p.m.—Venetian Room

MICROWAVE PROPAGATION

"Forward Scatter of Electromagnetic Waves by Spheres" by W. E. Kock, J. L. Stone, J. E. Clark, W. D. Friedle, Bendix.

"Propagation Through Random Distribution of Spheres: I. Theory and Design of Macroscopic Gas; II. Design of Range and Experimental Data," by C. I. Beard and V. Twersky, Sylvania.

"Surface Waves on a Wedge" by F. Karal and S. Karp, NYU.

"New Concepts in the Statistical Study of Tropospheric Scatter Propagation Data" by L. P. Yeh, Westinghouse.

21-Wednesday, August 20
8:00 to 9:30 p.m.—Embassy Room

BIOLOGICAL MEASUREMENT IN SPACE TRAVEL

"Survival" by Brig. Gen. D. Flickinger, ARDC.

"Performance" by B. H. Levedahl, UCLA, and A. W. Heatherington, ARDC.

"State of Art in Measurement" by Miss F. Van Der Wal, R-W.

"Future Instrumentation Problems" by F. W. Leahn, R-W.

22-Wednesday, August 20
8:00 to 9:30 p.m.—Sunset Room

SPECIAL SESSION
PROJECT MANAGEMENT—AIRFRAME AND ELECTRONICS VIEWPOINTS

G. Stoner, Boeing; O. Simpson, Philco; R. L. Shelter, GE.

23-Thursday, August 21
9:30 am. to Noon—Embassy Room

ANALOG COMPUTERS

"Anticipatory Display Design Through the Use of an Analog Computer" by L. J. Fogel, and M. Dwonczyk, Convair.

"A Transistorized Trigonometric Function Generator" by H. Schmid, Link.

"An Analog Memory" by W. S. Kozak, Canadian Westinghouse Co.

"Network Solution of the Right Triangle Problem" by M. R. Winkler, Goodyear.

24-Thursday, August 21
9:30 a.m. to Noon—Sunset Room

MICROWAVE AND HIGH POWER TUBES

"A New Design Approach for a Compact, Kilowatt, UHF Beam Power Tube" by F. W. Peterson, RCA.

"A Low Voltage Helix Type Backward Wave Oscillator with Extended Tuning Range" by L. L. Maninger, Sylvania.

"Are Klystron Amplifiers Inherently Noisy" by R. Rockwell, Varian Associates.

"A New Crossed Field Traveling Wave Tube, the M-J Tube" by C. C. Johnson and G. K. Birdsall, GE.

"Design of Traveling-Wave Tubes for Airborne Applications" by M. Nowogrodzki, RCA.

25-Thursday, August 21
9:30 a.m. to Noon—Boulevard Room

MILITARY ELECTRONICS

"Economic Analysis in Long Term Planning of Military Communication-Systems" by R. Krzyczkowski, Westinghouse.

"Will Timing Systems Become Heterogeneous or Homogeneous?" by D. B. Proctor, Electronic Engineering Co.

"Automatic Missile Systems Test Considerations" by J. I. Davis, Hoffman.

"Frequency Multiplex Doppler Radar" by J. Galejs, Sylvania.

"Talos Land Based System Digital Checkout Equipment" by F. X. Beck, RCA.

26-Thursday, August 21
9:30 a.m. to Noon—Ballroom

IMPROVED COMPONENT MATERIALS

"Advances in Ceramic Components" by H. M. Schlicke, Allen-Bradley Co.

"Monolithic Structure—A New Concept for Ceramic Capacitors" by J. Fabricius, Sprague.

"Upgrading the Tantalum Capacitor" by W. H. Roberts, GE.

"The Thermally Fused Metal-to-Ceramic Varistor" by R. C. Langford, Weston.

"Factors Affecting the Formation of Deposited Carbon Film Resistors" by E. I. Doucette, Bell Labs.

27-Thursday, August 21
9:30 a.m. to Noon—Venetian Room

ANTENNA ARRAYS

"Arbitrarily Polarized Slot Array" by H. H. Hougardy and H. E. Shanks, Hughes.

"Logarithmically Periodic Antenna Arrays" by R. H. DuHamel and D. G. Berry, Collins.

"Impedance Properties of Antenna Arrays" by S. Edelberg, MIT, and A. A. Oliner, Polytechnic Inst. of Bklyn.

"Antenna Pattern Synthesis of the Most Truthful Approximation" by H. P. Raabe, General Mills.

"A Rapid-Scanning Phased Array" by R. E. Miller, A. T. Waterman, Jr., G. K. Durfey and W. H. Huntley, Jr., Stanford U.

28-Thursday, August 21
2:00 to 4:30 p.m.—Embassy Room

SPECIAL ELECTRON DEVICES

"Voltage Sensitive Semiconductor Capacitors" by M. E. McMahon and G. F. Straube, Pacific Semiconductors.

"The Hall Effect Circulator—A Passive Transmission Device" by W. J. Grubbs, Bell Labs.

"Stacked Tubes in Glass Envelopes" by C. F. Douglass, Sylvania.

"A Lightweight Kilowatt Klystron Amplifier for

Aerial Navigation Systems" by R. Rockwell, Varian Associates.

"Characteristics and Control of Gas Tube Duplexers During their Recovery Time" by R. E. Hovda and E. R. Roehl, Autonetics.

29-Thursday, August 21
2:00 to 4:30 p.m.—Sunset Room
HUMAN FACTORS IN ENGINEERING

"A Review and Summary of Tracking Research Applied to the Description of Human Dynamic Response" by D. T. McRuer, Systems Technology, and E. S. Krendel, The Franklin Institute.

"Synthesis of a Linear Quasi-Transfer-Function for the Operator in a Man-Machine System" by A. S. Jackson, Cornell U.

"The Optimization of Man-Machine Control Systems" by H. P. Birmingham, NRL.

"SIBYL: A Laboratory for Simulation Studies of Man-Machine Systems" by H. D. Irvin, Bell Labs.

"Simulation of a Human Tracking Problem on the UDEC III Computer" by B. Platzer, Burroughs.

30-Thursday, August 21
2:00 to 4:30 p.m.—Boulevard Room
MICROWAVE FERRITES

"Circular Electric Waves Propagating thru Circular Waveguide Containing a Circumferentially Magnetized Ferrite Cylinder" by N. Kumagai, U. of Osaka.

"A Wide-Band Nonreciprocal TEM Transmission-Line Network" by E. M. T. Jones, S. B. Cohn and J. K. Shimizu, SRI.

"Field Displacement Effects in Dielectric and Ferrite Loaded Waveguides" by T. M. Straus, Harvard U.

"Ferrite Line Width Measurements in a Cross-Guide Coupler" by D. C. Stinson, Lockheed.

"Tee Circulator" by W. E. Swanson and G. J. Wheeler, Sylvania.

31-Thursday, August 21
2:00 to 4:30 p.m.—Ballroom
COMPONENT PARTS

"A Solution to the Sampling vs. Rating Dilemma on Electronic Components" by B. Hecht, B. Hecht & Associates.

"Design and Performance of Static-Magnetic Regulated DC Power Supplies" by J. T. Keefe, Sola Electric.

"Design of Semi-Conductor Magnetic Voltage Regulator Reference Circuits for a Wide Range of Environments" by E. Q. Carr and K. P. Worcester, GE.

"Dynamic Temperature Coefficient Measurements" by A. S. Takacs and F. Baron, Vitramon.

"Development of 500 Degrees C Low Loss, High Frequency Cables" by E. T. Pfund, Jr. and B. Suverkrop, United Electrodynamics.

32-Thursday, August 21
2:00 to 4:30 p.m.—Venetian Room
RADIO AND TELEVISION BROADCASTING

"Field Experience with the Kahn Compatible Single Sideband System Installed at KDKA, Pittsburgh, Pa." by R. N. Harmon, Westinghouse.

"Head Drum Stabilization for Recording the NTSC Color Signal" by J. Kabell, SRI.

"Frequency Measurement in the Broadcast Field" by C. A. Cady and W. P. Buuck, General Radio.

"Remote Control and Automatic Logging of AM, FM and TV Broadcasting Transmitters and Automatic Programming of AM and FM Broadcasting Stations" by P. C. Schafer, Schafer Custom Engineering.

"Automatic Control of Videotape Equipment at NBC, Burbank" by R. Ryloff, NBC.

33-Friday, August 22
9:30 a.m. to Noon—Embassy Room
SOLID STATE I

"A Family of Diffused-Base Germanium Transistors" by H. E. Talley, Bell Labs.

"Millimicrosecond Diffused Silicon Computer Diodes" by J. H. Forster and P. Zuk, Bell Labs.

"Diode Recovery Time Measurements in the Millimicrosecond Region" by A. E. Bakanowski, Bell Labs.

"The Design and Characteristics of a Diffused Silicon Logic Amplifier Transistor" by L. E. Miller, Bell Labs.

"Switching Time Calculations for Diffused Base Transistors" by V. H. Grinich and R. N. Noyce, Fairchild Semiconductor Division.

34-Friday, August 22
9:30 a.m. to Noon—Sunset Room
PRODUCTION TECHNIQUES

"A Fresh Approach to Modular Packaging for Ground Based Electronic Equipment" by C. W. Watt, Consolidated Electrodynamics.

"Insulated Flexible Printed Circuits" by W. Wilkens, Sanders Associates.

"Design and Semi-Automatic Production of Stacked Ceramic Receiving Tubes" by R. H. Chamberlain, Eitel-McCullough.

"Honeycomb Structure Rigidizes Printed Wiring for High Vibration" by E. O. Deimel, GE.

"New Organic Coatings for the Protection of Printed Circuits Under Environmental Conditions" by E. Harmon, J. Heffernan and J. Staller, American Bosch Arma.

35-Friday, August 22
9:30 a.m. to Noon—Boulevard Room
ANTENNAS AND PROPAGATION

"The Influence of the Radar Reflection Characteristics of the Moon on the Specifications for Earth-Moon-Earth Communications Systems" by T. B. A. Senior and K. M. Siegel, U. of Michigan.

"Microwave Technique to Reduce Platform Motion

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"A Concentric Loop Array" by A. C. Schell and E. L. Bouche, USAF.

"Theory and Design of a Class of Luneberg Lenses" by J. R. Huynen, Lockheed.

"Obstacle Gain at Microwave Frequencies" by S. R. Bradshaw, Motorola.

36-Friday, August 22
9:30 a.m. to Noon—Ballroom
INDUSTRIAL ELECTRONICS

"A Numerical Control System for a Drivmatic Riveter" by R. D. Borsos and Hank M. Lakin, Lockheed Aircraft.

"A High Performance 500 Mc Multi-Stage Amplifier" by M. W. Hamilton and J. W. Rush, GE.

"Transistor Decade Counter" by Alexander Szertip, Packard-Bell Electronics.

"Some Digital Industrial Electronic Systems and Their Military Heritages" by D. E. Wassall, Bendix.

"Thermal Considerations in Regulated Power Supply Design" by Roger Wileman, Packard-Bell.

37-Friday, August 22
9:30 a.m. to Noon—Venetian Room
ADVANCED TELEVISION TECHNIQUES

"Techniques for Rapid Alignment of Critical Bandpass Circuitry" by W. A. Sebastian, GE.

"Transistorized Television Receiver" by R. R. Webster and H. F. Cooke, TI.

"Design and Use of the Chroma Key" by F. J. Gaskins, NBC.

"Scan Magnification" by D. R. Skoyles and R. H. C. Morgan, Mullard Research Labs.

"Distortion Reduction in Television Reception" by J. Ruston and W. J. Judge, Dumont.

38-Friday, August 22
2:00 to 4:30 p.m.—Embassy Room
SOLID STATE II

"Comparison of Neutron Damage in Germanium and Silicon Transistors" by J. W. Easley, Bell Labs.

"High Power Silicon Transistors" by H. W. Henkels and T. P. Nowalk, Westinghouse.

"A Medium Power Silicon Controlled Rectifier" by D. K. Bisson, GE.

"PN II N Switches" by J. A. Hoerni and R. N. Noyce, Fairchild.

"A New Diode for Switching and Oscillator" by L. Esaki, Sony Corp., Japan.

39-Friday, August 22
2:00 to 4:30 p.m.—Sunset Room
MEDICAL ELECTRONICS

"The Design of Electronic Correlating Equipment to be used in Medical Research" by L. M. Kaplan, Space Technology Labs.

"Electronic Aids to the Service of Obstetrics" by S. D. Larks, UCLA.

"A Servomechanism for Automatic Regulation of Breathing" by G. H. Myers, Bell Labs., and G. A. Saxton Jr., U. of Illinois.

"Fetal Heart Rate Measurements" by W. E. Tolles, AIL.

40-Friday, August 22
2:00 to 4:30 p.m.—Boulevard Room
ANTENNAS

"A Broadband, Low Sidelobe Radar Antenna" by A. M. McCoy, J. E. Walsh, C. F. Winter, Raytheon.

"A Class of Low Gain Broadband Antennas" by B. J. Lamberty, Sylvania.

"Illuminating Curved Passive Reflector with Defocused Parabolic Antenna" by R. F. H. Yang, Andrew Corp.

"Reflector-Type Periodic Broadband Antennas" by R. E. Franks and C. T. Elfving, Sylvania.

"The 360 Degree Parabolic Torus Antenna" by J. D. Barab, J. G. Maramgoni and W. G. Scott, Melpar.

41-Friday, August 22
2:00 to 4:30 p.m.—Ballroom
ENGINEERING WRITING AND SPEECH

"Publications and the Project Organization" by M. H. Lowe, RCA.

"A Two-Hour Course in Report Writing" by R. E. Holmann, IBM.

"Should Slides be Used in a Technical Presentation?" by C. L. Lillo, Remington Rand.

"Making the Mathematical Equation an Effective Communication Tool" by M. Hollander and E. J. Podell, RCA.

"A Multi-Purpose, Multi-Audience Speech Kit," by I. Seligsohn, System Development Corp.

42-Friday, August 22
2:00 to 4:30 p.m.—Venetian Room
COMMUNICATION SYSTEMS AND VEHICULAR COMMUNICATIONS

"A Method of Improving Reception in FM Communications" by H. D. Hern and M. S. Ulstad, Collins Radio.

"Effective Split-Channel Utilization—A Challenge to the Communication System Engineer" by C. J. Schultz, Motorola.

"A Double Sideband Suppressed Carrier AM Communications System" by J. W. Halina, FTL.

"Application of Automatic Level Control in Tropospheric SSB Communications Systems" by A. J. Valdasz, GE.

"Personal Radio Signalling, a Telephone Service" by N. Monk, Bell Labs, and E. Gueonsey, Ohio Bell Telephone.

EXHIBITORS

Exhibitors at the show and booth numbers are as follows:

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AC Electronics Inc. 712
AMP Inc. 1228-1229
AMP Inc., Capitron Div. 914
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Accurate Instrument Co. 1916
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Ace Eng. & Machine Co. 226
Acoustica Assoc., Inc. 121
Advance Relays, Electronics Div., Elgin National Watch Co. 1250
Advanced Electronics Mfg. Corp. 921B
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Alford Mfg. Co. 817-818
Alfred Electronics 519
Allen-Bradley Co. 1321-1322
Allied Control Co., Inc. 1359
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Altec Lansing Corp. 1449
Alto Scientific Co., Inc. 1106
Amco Eng. Co. 1625-1626
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American Machine & Foundry Co., Defense Products Group 521
American Mach. & Foundry Co. 525-526
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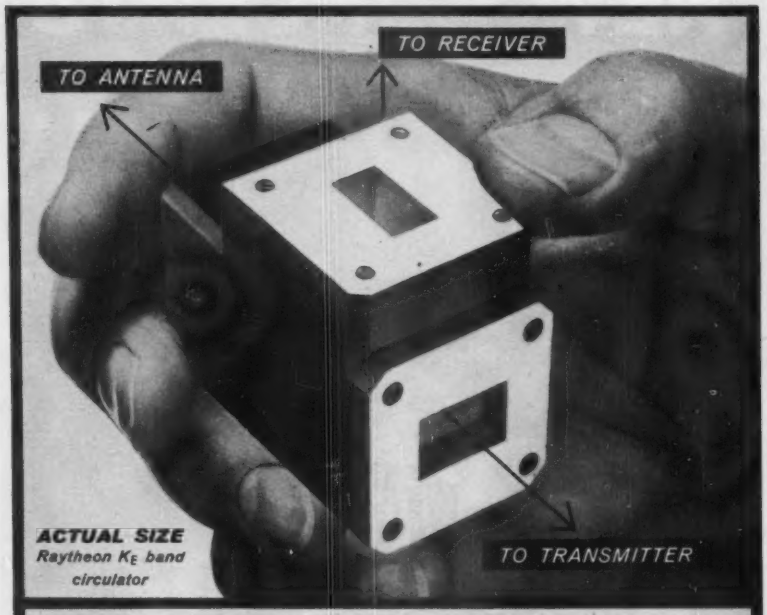

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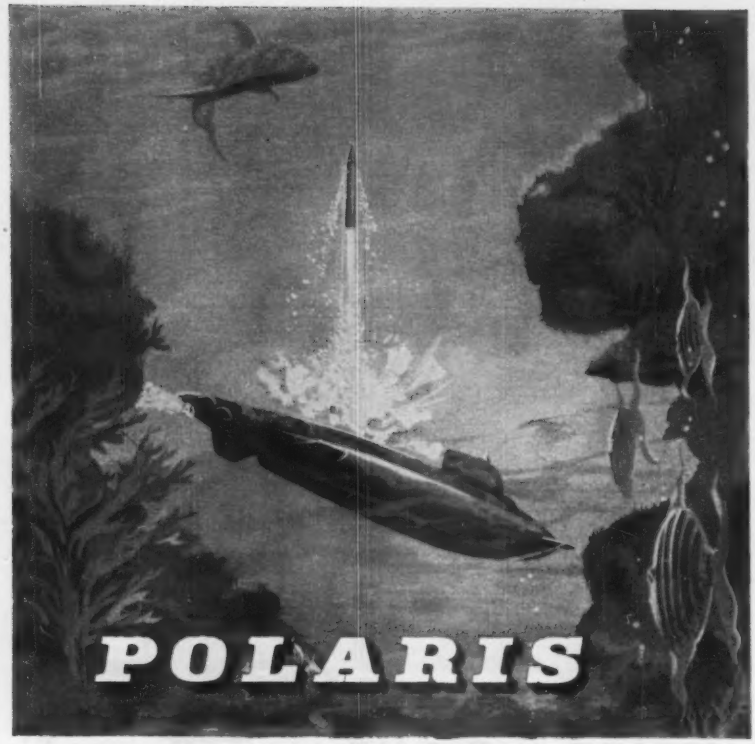

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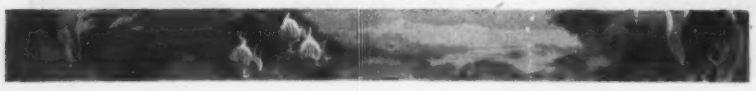

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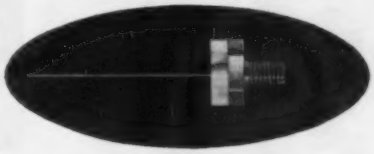

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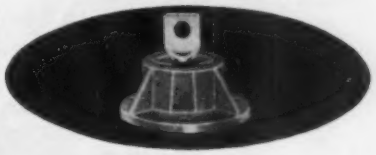

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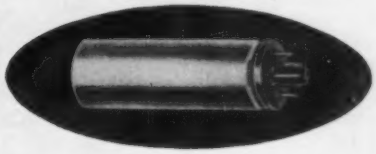

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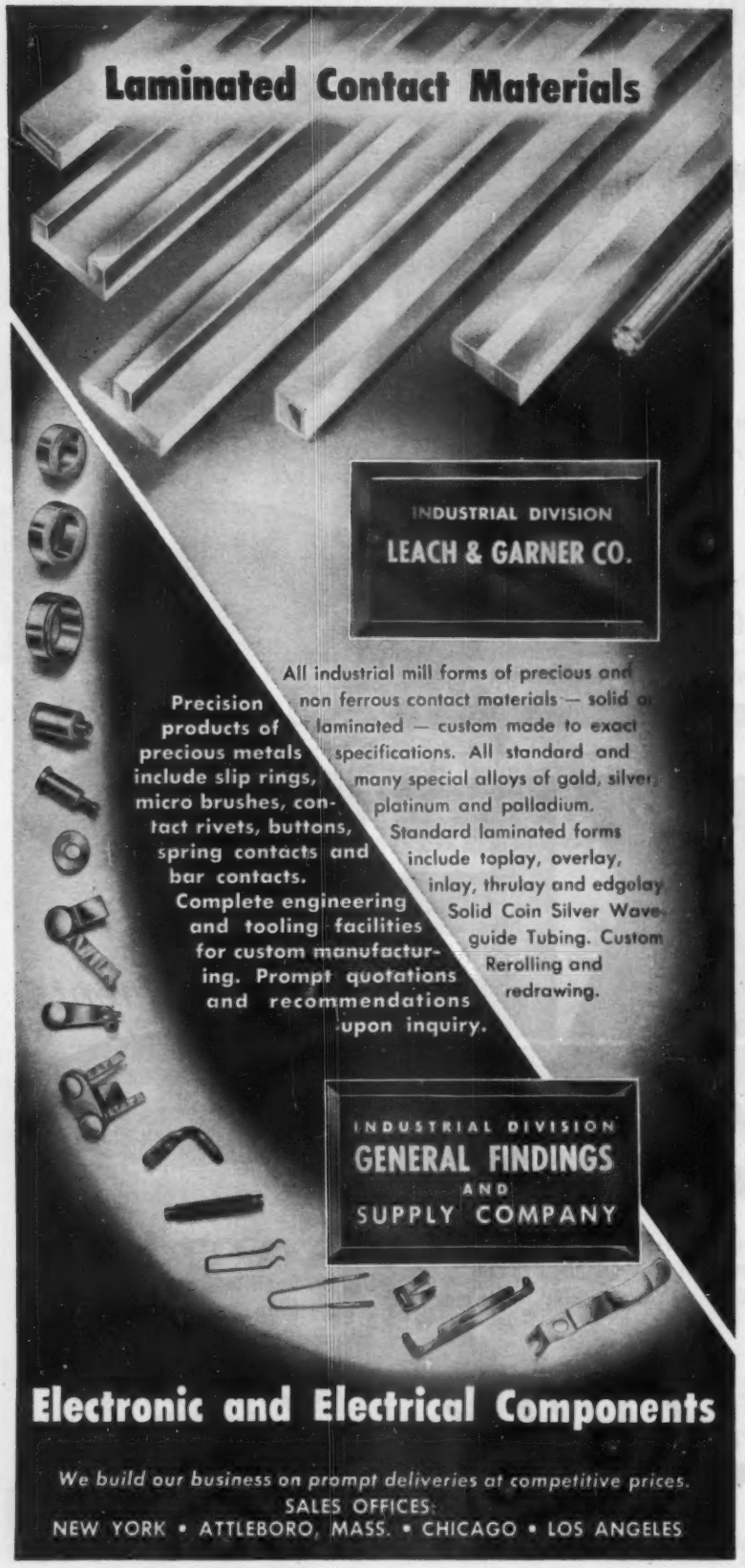
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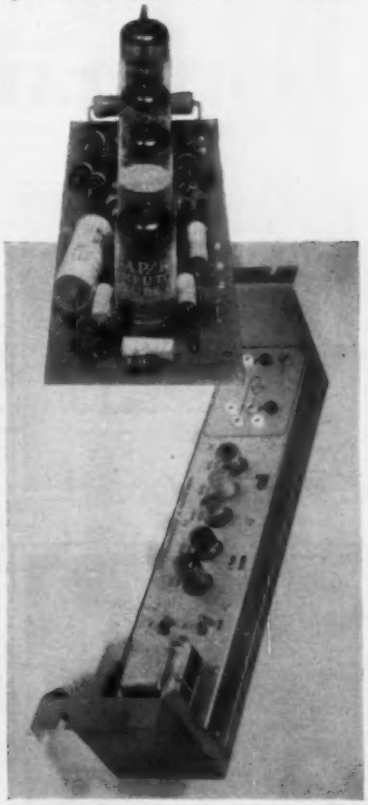

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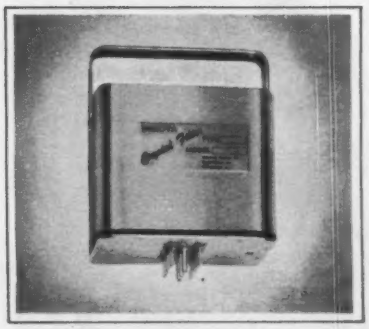

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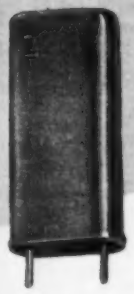

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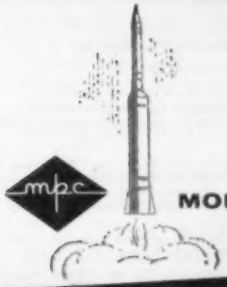

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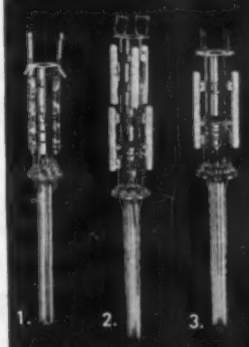

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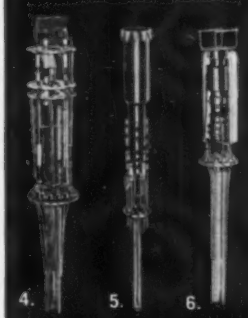

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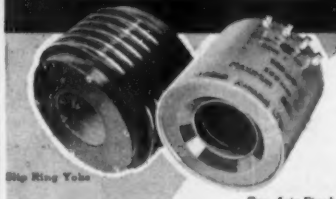

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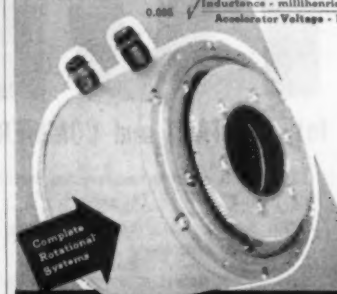

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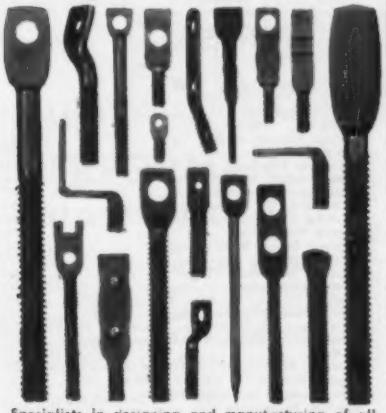

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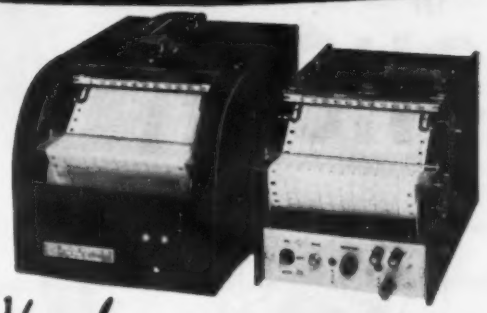

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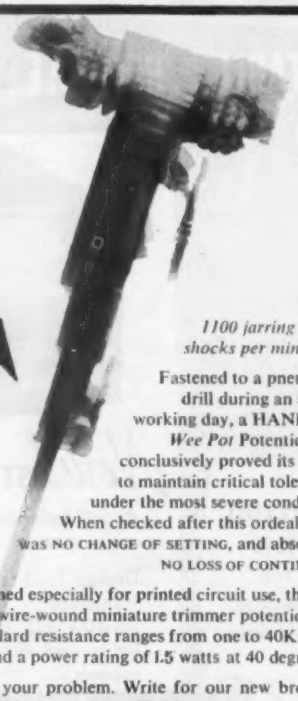

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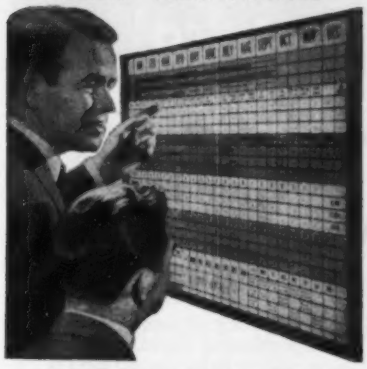

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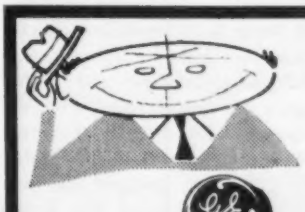

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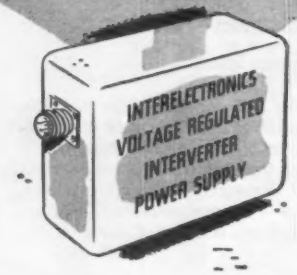

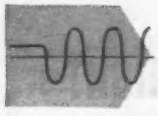

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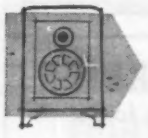

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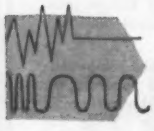

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Interscience Publishers, Inc., New York, 1957, 339 p, $5.00.

THE Symposium on the Role of Solid State Phenomena in Electric Circuits was seventh in an annual series sponsored by the Polytechnic Institute of Brooklyn in cooperation with the Institute of Radio Engineers and cosponsored by military research and engineering laboratories. It was the first of the annual symposia devoted to solid state phenomena. The major emphasis of the symposium was the application of solid state devices to electric circuits.

Context—The 24 papers report progress and development in solid state physics of interest to the electronic engineer.

The first three papers review the state of the art. They describe the physical phenomena and indicate the circuit aspects of primary interest to the engineer. Next are five papers grouped under the topic heading "Basic Processes and Techniques". Considered here are solid state amplifiers and new applications of indium antimonide and organic plastic semiconductors.

The third group, also of five papers, is devoted to "Semiconductor Properties and Techniques". These papers discuss compound semiconductors, quasi electric and quasi magnetic fields in nonuniform semiconductors and carrier response time in various transistor applications. Some novel transistor effects are also considered.

"Magnetic Properties and Techniques", the fourth group, considers Super Conductivity, Ferrites and core swtching. Under "Photo Techniques" are grouped the remaining six papers of the Symposium. Luminescence photoconductive switching, infrared and microwave modulators, optical and electrical crystal properties and polarization in photo conductors are the topics in this last group.

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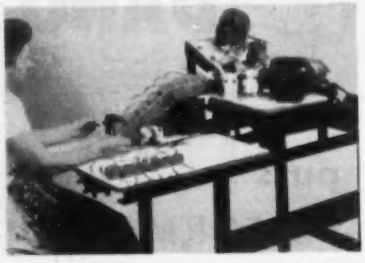

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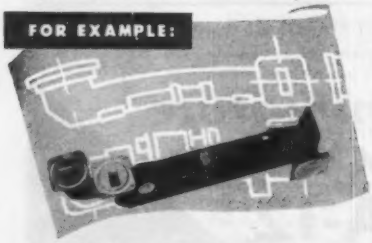

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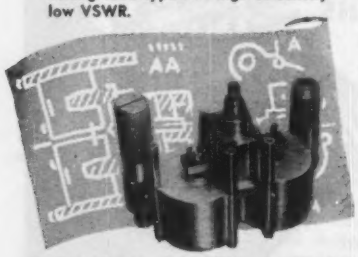

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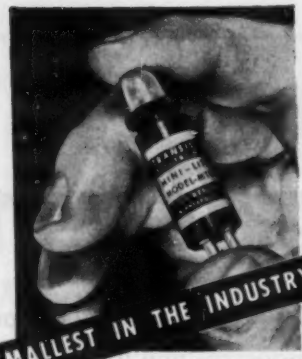
THUMBNAIL REVIEWS

Die Senderohre Als Oszillatorrohre (The Transmitter Tube as an Oscillator). By N. Weyss, Brown, Boveri & Cie. AG., Mannheim, Germany, 1957. A detailed analysis of class C oscillators and nomographs to aid the design of this type of circuit.

Bibliography on Shock and Shock Excited Vibrations—Vol. I. Edited by J. N. Brennan, Pennsylvania State Univ., College of Engineering and Architecture, University Park, Pa., 1957, $2.00. Abstracts of 1,168 technical papers covering theoretical and analytical methods, experimental methods and equipment, packaging and isolation, etc.

The Numerical Solution of Two Point Boundary Problems. By L. Fox, Oxford University Press, New York, 1957, 371 p, $9.60. This fairly complete treatment of the numerical methods of solving a variety of numerical mathematical equations, including difference, algebraic and ordinary differential, is suitable for a person having only a knowledge of college mathematics up to and including differential equations.

An Introduction of Transistor Circuits. By E. H. Cooke-Yarborough, Interscience Publishers Inc., New York, 1957, Elementary introduction to transistor theory and circuit applications, with emphasis on nonlinear properties of transistors.



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COMMENT

A Clash of Symbols

(In Comment, June 20, p 158) you printed a letter on the subject of symbols for the silicon controlled rectifier, together with a note calling for comments. It seems to me that the general field of symbols standards is somewhat confused by strong opinion, usually based on presumptions that indicate a startling lack of familiarity with the function of the Institute of Radio Engineers.

As you know, the IRE is an industry-wide organization of some 60,000 members of the electrical engineering profession. One of the responsibilities of the Institute is to obtain industry-wide acceptance of consistent terminology and symbology in the various fields of electronics. In order to facilitate such acceptance, IRE operates within a set of ground rules that have proved satisfactory over a period of many years.

The IRE does not generate symbols; rather, it reflects the majority opinion. Symbol structure must be a logical extension of a well-accepted symbol, and must be capable of extension to new devices as the state of the art progresses. A symbol should *not* be based on the theory of operation of the device; theories have a habit of being improved continuously, and to keep changing the symbol would only result in chaos. A symbol should indicate the physical properties *where possible without complication.*

It was on the basis of these rules that the present symbol standards were evolved. These have been circulated among, and after revision accepted by, a majority of industry representatives.

The symbol recommended by the authors of the paper "Solid State Thyratron Switches Kilowatts" (Mar. 28, p 52) does not conform with the IRE standard. Unfortunately, neither does the one ELECTRONICS used.

These are the IRE symbols for a *pnpn* structure of the conjugate emitter type with an *n*-gate terminal

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SM-60	1/100 min.	60 min.	±.002 min.
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S-6	1/1000 min.	10 min.	±.0002 min
S-1	1/100 sec.	60 sec.	±.01 sec.
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with an *n*-type emitter instead of a collector

and a region discontinuity in the base.

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IRE Semiconductor Device Symbols Task Group
Syracuse, N. Y.

Attenuation

The article "Path Attenuation Nomograph" (June 6, pp 98-100) appears to be in error. The formula given on p 100 should express d in statute miles rather than in feet. The value of the constant generally used is 37 rather than 37.9 as presented in the article.

As for the constant value, I have found the number 36.62 to be more nearly correct.

J. Herrmann
Indianapolis 22, Ind.

For the basic equation, d should indeed be in miles. Because of the shorter distances involved, the nomograph was made in feet, but would have to be converted to miles for the equation. The value 37.9 was supplied by the author; this figure seems to vary from one source to another, and perhaps 36.6 is more nearly correct.

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The Advertisements in this section include all employment opportunities—executive, management, technical, selling, office, skilled, manual, etc.

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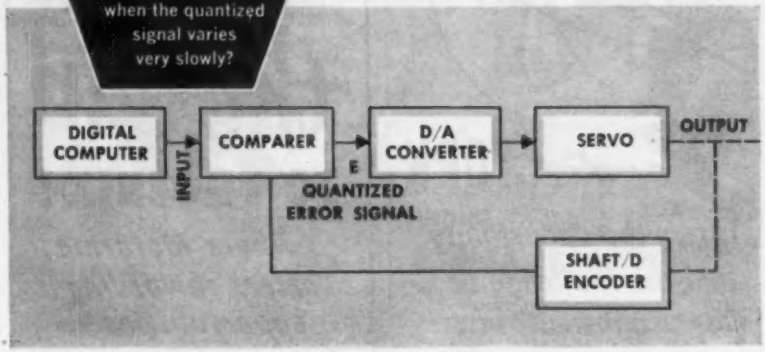

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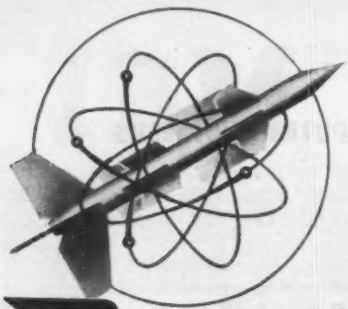

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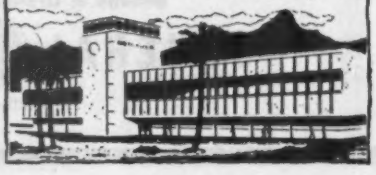

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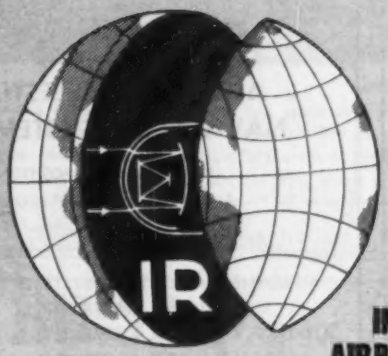

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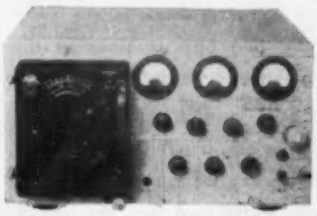

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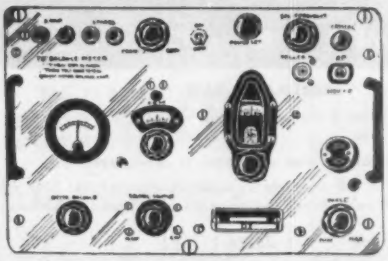

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NEW TS148/UP X BAND SPECTRUM ANALYZER

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Test Set TS 147 UP is a portable Microwave Signal Generator designed for testing and adjusting beacon equipment and radar systems which operate within the frequency range of 8500 MC to 9000 MC.

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TS12/AP	1954A	TS117	TS254	APA38
TA13/AP	TS-45	TS125/AP	TS258	APS3/APS4
TS14/AP	TS45	TS126/AP	TS259	APT2-APT5
TS15	TS47/APR	TS173	TS270	BC152C
TS16	TS63	TS174/AP	TS299	BC788C
TS27	TS67	TS175/AP	TS419	UPM1
TS28	TS69/AP	TS182	TS497B	UPM7
TS33/AP	TS100	TS186	TS535	UPM30
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CV-12/APR-6. Mixer Assy. for APR-6 receiver, 4000 mc.-6000 mc. Tunable C Band waveguide....$24.50
CV-13 Mixer Assembly for APR-6 receiver. The mixer is designed to cover the range 2000 to 4000 mc. **$22.50**
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BC 911, dual coax. switch. With British connectors. Useful up to 400 mc....$2.50
90 deg elbows, "L" Band, with flanges. "H" Plane....$18.55
Armatures for BDS6 dynamotors....$2.50
Antenna Strain Insulators: Johnson #136-151....$2.00
Sawtooth potentiometer, W.E. #K8151J3RLO-1. 100 ohms 5.76 Watt. Delivers sawtooth current waveform 360 deg. contin. rotation. Brushes 180 deg. apart....$2.50
Capacitor, GE Pyranol, #14F105. 0.25 mfd/25,000 vdc....$18.95
Receiver front end cavity resonator: Tunes 2700 to 3400 mc with a loaded Q of 3000. 50-ohm, type N input. Video output from 1N27 crystal. May be used at quarter wave (1.1 to 1.4 kmc)....$22.50

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Type	INPUT Volts	Amps	OUTPUT Volts	Amps	Price
BDAR83	14		375	.150	$ 6.50
POSX-15	14	2.8	220	.08	5.50
DM33A	28	7	540	.250	3.50
B-19	12	9.4	275	.110	5.50
			500	.050	
DA-3A	28	10	300	.260	3.50
			150	.010	
			14.5	5.	
PE 73	28	19	1000	.350	10.50
BD 69	14	2.8	220	.08	8.95
DAG-33A	28	3.2	450	.06	2.50
BDAR 93	28	3.25	375	.150	5.00
PE 94—BRAND NEW					4.75

Navy type CAJO-211444. Input: 103 to 130 VDC. Output: either 26 VDC at 26 amps or 13 VDC at 40 amps. Radio filtered and complete with line switch....$44.00

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800-1B input 24-vdc, 62A. output: 115 V. 800 cy. 7A 1 phase. Used excellent....$12.00
PE-218H: Input: 28/30vdc, 92 amp. Output: 115 V 300/500 cy. 1500 Volt-Ampere....$26.00
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X-BAND—RG, 52/U WAVE GUIDE

PARABOLOID DISH, 18" diam. Spun Aluminum 8" Focus. For AN/APS-6....$4.50
3 CM DIPOLE and Feed Assembly (May be used with above dish.) 8 inches long....$5.00
FLEXIBLE SECTION 9 in. long. Cover-to-Cover. $5.50
30° Parabolic Reflector Spun Aluminum dish 10¼" Focus....$4.85
3 CM. DIPOLE FEED, 15" L. for APS-15 10¼" focus....$12.50
MITRED ELBOW. Cast Aluminum, 1⅝" x ⅝" WG. W. E. Flanges. "E" PLANE....$3.50
Cross-Guide Directional Coupler. UG-40 output flange, Main Guide is 6" Long, with 90 Deg. "E" Plane bend at one end, and is fitted with Std. UG 39/TG 40 flanges. Coupling figure: 20 db Nominal....$15.00
Pressure Gauge Section with 15 lb. gauge....$10.00
Directional Coupler, UG 40/U take off 20db....$15.00
MAGNET AND STABILIZER CAVITY For 2J41 Magnetron....$24.50
90 degree elbows, "E" Plane 2½" radius....$8.50
Beacon/receiver unit. Complete with dual klystron mount, TR/ATR section, duplexer, and 30 mc IF/- Mixer unit. Originally designed for 9000 mc receiving using 723A/B. New, less tubes....$22.50
3 CM ANTENNA ASSEMBLY: Uses 17" paraboloid dish, operating from 24 vdc motor. Beam pattern; 5 deg. in both Azimuth and elevation. Sector Scan; over 160 deg. at 35 scans per minute. Elevation Scan, over 2 deg. Tilt. Over 24 deg....$35.00

MICROWAVE MAGNETRONS

2J21A	$3.50	2J37	$9.00	2J62	$3.00
2J22	$7.50	2J38	$12.50	725A	$5.00
2J26	$5.50	2J39	$12.95	QK60	$19.50
2J27	$3.50	2J48	$30.00	QK61	$18.95
2J31	$12.50	2J61	$8.25	QK62	$18.00

MEDIUM POWER PULSER

The MIT MOD III PULSER is a lightweight, medium power radar modulator using an 829 B in a regenerative blocking oscillator circuit feeding a 715B power amplifier. Peak output is 12 KV at 12 Amps into a 0.5/1.0/2usec. at a 1000 ohm load. Pulse widths are duty ratio of 0.001. Primary power requirements are: 115 vac 400-1200 cps/3.5A. Also 28 vdc at 5 Amp. An external trigger of at least 50 v. peak is required. All units are new, complete with all tubes, pressurized housing, and schematic diagram **$97.50**
(Refer to RadiLab Series, Vol. 5, Sec. 5.1)

PULSE TRANSFORMERS

352-7150. Primary 50 ohms. Secondary 1000 ohms. 12,000v, 12.0 Amp Pulse: 1 or 2 usec. at .001 duty ratio. Fitted with magnetron well and bifilar winding for filament supply....$22.50
K-2745 Primary: 3.1/2.8 KV, 50 ohms Z Secondary: 14/12.6 KV 1025 ohms Z. Pulse length: 0.25/1.0 usec @ 600/600 PPS Pk Power 200/150 KW. Bifilar: 1.3 Amp. Has "built-in" magnetron well....$32.50
K-2461-A Primary: 3.1/2.6 KV—50 ohms (line). Secondary 14/11.5 KV—1000 ohms Z. Pulse length: 1 usec @ 600 PPS. Pk. Power Out: 200/130 KW. Bifilar 1.3 Amp. Fitted with magnetron well....$29.50
GE #K-2458A, Primary: 9.33 KV, 50 ohms Imp. Secondary: 28 KV, 450 ohms. Pulse length: 1.05/5 usec @ 635/120 PPS, PK Power Out: 1,740 KW. Bifilar: 1.5 amps (as shown)....$62.50
GE @K-2748-A, 0.5 usec @ 2000 Pps. Pk. Pwr. out is 52 KW impedance 40:100 ohm output. Pri. volts 2.3 KV Pk. Sec. volts 11.5 KV Pk. Bifilar rated at 1.3 Amp. Fitted with magnetron well....$24.50

I. F. AMPLIFIER STRIPS

Model 15: 30 mc center freq. B.W. 2.5mc. Gain: 65db, uses 5 stages of 6AC7. Has DC restorer and video detector. Input impedance: 50 ohms. Less tubes.**$15.00**
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60 MC. Miniature IF strip, using 6AK5's 60 Mc center Freq. Gain: 95 db at Bandwidth of 2.7 Mc. New. Complete with tubes....$15.00

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3.6 RPM	3.45	1 RP12Hr.	3.25

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115v 18 watt....$4.50
same motor 8 RPM....8.50

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1 RPM 230v 60cy....1.00
2 RPM 230v 60cy....1.00
3 RPM 115v 60cy....2.80
30 RPM 115v 60cy....2.80
450 RPM 115v 60cy....1.30
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OA3	.80	2K42	125.00	6AK4	1.00	CEP220	2.00
OB2	.50	2K44	100.00	6AK5W	1.00	QK221	Q
OB2WA	2.00	2K45	15.00	6ALSW	.60	2J1D	2.00
OB3/VR90	.70	2K46	199.50	6ANS	2.10	RX-233A	.50
OC3/VR105	.45	2K47	100.00	6ANSWA	4.25	FG-233A	25.00
OD3/VR150	.40	2K48	15.00	6AN8	1.25	FG-238A	50.00
1AE4	1.25	2K50	120.00	6AN8	1.25	QK-243	49.50
1B22	1.00	2K54	13.00	6AS6	1.00	WE-245A	2.75
1B23	1.00	2K55	15.00	6AS6W	.60	QK-246	200.00
1B24	4.50	2SM15	8.75	6AU6WA/6136	2.00	QK-249	125.00
1B24A	12.00	3AP1	1.50	GBP7	2.25	WE-249B	2.50
1B25	1.25	3AP1WA	25.00	6BL6	30.00	WE-249C	2.75
1B26	.80	3ACP7	15.00	6BM6	27.50	250R	4.00
1B27	6.50	3B4	1.50	6BM6GA	1.50	250TH	21.00
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1B35	2.75	3B22	5.00	6D4	1.20	WE-251A	35.00
1B37	3.00	3B24	3.00	6DQ5	175.00	WE-252A	6.50
1B38	22.00	3B24W	3.50	6HGWGT	1.25	WE-254A	2.50
1B40	1.30	3B24WA	7.00	GJ4	1.00	HK257B	7.00
1B42	4.00	3B28	1.25	GJ4WA	1.40	FG-258A	70.00
1B44	8.00	3B26	2.50	6JSWGT	1.00	WE-258B	10.00
1B45	35.00	3B29	4.25	6JSW	.60	259A	5.00
1B47	2.50	3C4	1.95	6K4	2.00	V-262	150.00
1B51	6.75	3C22	37.00	6L6WGA/5932	2.70	FP265	10.00
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1B55/R11308	12.00	3C30	2.50	6SK7W	.70		
1B62	2.50	3C33	4.50	6SL7WGT	1.00		
1B61A	12.50	3C45	4.50	6SN7WGT	.90		
1B66	6.00	3DP1-S2	6.00	6SQ7GTY	2.00		
1N21B	.80	3DP11A	5.00	6V6GTY	.70		
1N23	.25	3E29	6.00	7AK7	2.75		
1N23B	.60	3FP7A	2.00	7BP7	1.00		
1N23BM	2.00	3JP1	6.50	7C23	60.00		
1N23C	1.00	3JP7	5.00	7MP1	10.00		
1N23E	5.00	3J30	22.50	7MP7	10.00		
1N25	.85	3K22	150.00	7QP4	10.00		
1N27	.70	3K30	90.00	7UP7	20.00		
1N28	5.00	3MP1	10.00	7XP2	100.00		
1N31	1.50	3W500A3	95.00	7YP2	50.00		
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1N38A	.35	4-400A	34.00	5RC12	149.50		
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1N42	8.00	4A3	2.00	12AU7WA	2.00		
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1N55	.50	4B24/HF100	12.00	12DP7	10.00		
1N55B	1.25	4B24/EL3C	5.00	12GP7	13.00		
1N58	.55	4B32	5.00	BL15	Q		
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1P22	4.00	4E27	24.00	HK-24	1.45		
1P24	1.35	4E27A	24.00	24G/3C24	2.75		
1P25	15.00	4J22 - 44line	Q	BL-25	15.00		
1P28	8.50	4J50A	29.50	FG-61	100.00		
1P36	2.50	4X150A	15.00	26AT6T	1.00		
1P37	2.50	4X150D	20.00	26D6	.50		
1P42	22.50	4X150G	35.00	26E6WG	2.50		
1S21	2.50	4X250M	35.00	FG-27A	20.00		
1Z2	1.40	4X500A	65.00	RK-28	10.75		
2AC15	7.50	5AK4	.75	28DW	2.50		
2AP1	2.00	5SB/5C30	1.00	RK29D	Q		
2AP1A	3.50	5SF14/6278	17.50	35T	5.00		
2AS15A	6.50	5AP1	2.25	35TG	6.00		
2B24	1.00	5BP2A	2.50	CE-36C	1.00		
2C35/RX233	.60	5BDP7	17.95	FG-43	100.00		
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2C37	20.00	5CP7	6.00	VC50-52	6.00		
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2C40	6.00	5CP11A	7.50	V-50XR	125.00		
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2C43	6.50	5D21	35.00	FG-57	5.00		
2C44	.20	5D22/RK65	3.75	QK-57	Q		
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2D21	.65	5JP5	2.00	HY65	.50		
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2E22	1.75	5J26	100.00	72	.25		
2E24	1.75	5J29	4.00	73	.25		
2E25	1.50	5J30	4.00	FG-81A	5.00		
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2E26	3.25	5LP1	8.50	FG97	25.00		
2E27	.60	5LP1A	20.00	FG98A	28.00		
2E32	1.00	5LP2A	15.00	RKR-72	.30		
2J36	20.00	5MP1	2.00	RKR-73	.30		
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2J42	55.00	5R4WGA	4.00	MF100	12.50		
2J48	9.00	5R4WGY	2.75	100R	1.50		
2J49	15.00	5RP11A	56.00	100TH	5.75		
2J50	30.00	5SP1A	50.00	WE-101D	2.00		
2J51	110.00	5SP7	45.00	WE-101F	2.00		
2J54	25.00	5SP11A	45.00	WE-121A	1.25		
2J55	45.00	5XP2	25.00	F-123A	3.75		
2J56	35.00	5XP2A	85.00	VT-127A	2.50		
2J61	8.00	5XP7	35.00	F-128A	7.00		
2J61A	30.00	5XP11	50.00	FG-154	8.50		
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2K23	11.00	5Y3WGT	1.30	BG0178	8.00		
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211/VT4C	1.00	QK381	65.00	802	2.00	5586	150.00
211E	.40	388A	Q	803	1.50	5591/403B	60.00
212E	10.00	WL-388A	1.00	804	7.50	5604	2.50
212F	13.50	393A	6.00	805	3.00	5606	Q
217A	7.50	WE-396A	3.00	806	6.00	5606A	150.00
217C	1.25	398A	6.00	807	1.25	5610	.75
218	14.00	403B/5591	2.50	807W/5933D	1.25	5611	45.00
CEP220	2.00	WE-404A	8.00	808	1.75	5614	2.75
QK221	Q	WE-406A	2.00	810	10.00	5627/FA-6	Q
231D	2.00	WE-409A	1.00	811	2.40	5634	4.50
RX-233A	.50	WE-412A	2.00	812	2.00	5636	2.25
FG-238A	25.00	WE-413A	3.00	813	8.50	5636A	2.75
FG-238B	50.00	WL-417A	2.25	814	1.50	5637	2.75
QK-243	49.50	WE-417A	8.50	815	1.00	5638	3.00
WE-245A	2.75	NE-418A	15.00	826	.50	5639A	4.00
QK-246	200.00	NE-421A	6.00	829	5.00	5641	2.00
QK-249	125.00	NE-422A	7.00	829B	8.00	5642	3.00
WE-249B	2.50	NE-423A/		832	3.70	5643	3.00
WE-249C	2.75	6146	4.00	832A	4.00	5645	5.00
250R	4.00	432A	6.50	834	4.00	5646	2.00
254TH	21.00	432B	8.00	836	1.50	5647A	1.50
254TL	12.00	434A	4.00	837	1.50	5650/5901	48.00
WE-251A	35.00	446B	1.00	838W	1.10	5651WA	2.75
WE-252A	6.50	450TH	40.00	841	6.00	5654/6AK5W	1.20
WE-254A	2.50	450TL	40.00	845	24.50	5654/6AK5W	
HK257B	7.00	WL-456	55.00	851	6.00	6096	1.90
FG-258A	70.00	QK459	250.00	852	8.00	5656	2.00
WE-258B	10.00	460	8.00	853	4.25	5657	125.00
259A	5.00	464A	2.00	860	12.50	5663	.60
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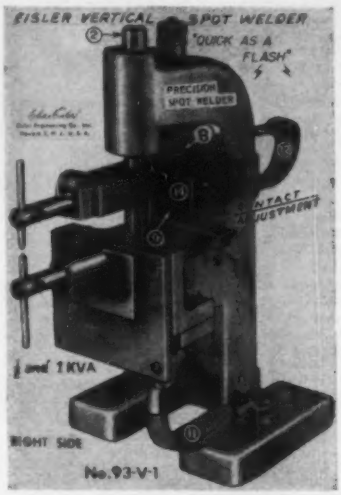

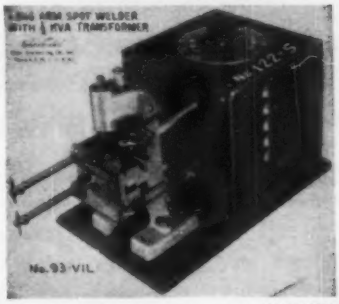

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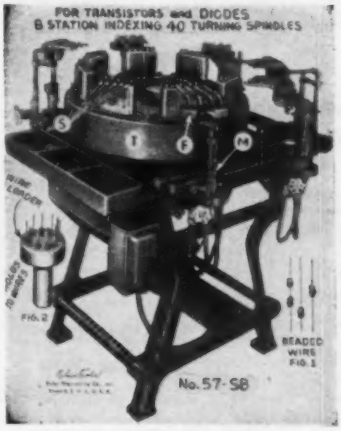

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Cat. No.	Hi Volt Sec.	ct	DC Volts	DC Amps	Filament #1 Volt	Filament #1 Amp.	Filament #2 Volt	Filament #2 Amp.	MIL Case Size
MGP1	400/200	V	185	.070	6.3/5	2	6.3	3	HA
MGP2	650	V	260	.070	6.3/5	2	6.3	4	JB
MGP3	650	V	245	.150	6.3	5	5.0	3	KB
MGP4	800	V	318	.175	5.0	3	6.3	6	LB
MGP5	900	V	345	.250	5.0	3	6.3	6	MB
MGP6	700	V	255	.250					KB
MGP7	1100	V	419	.250					LB
MGP8	1600	V	640	.250					NB

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Cat. No.	Secondary Volt	Secondary Amp	Test VRMS	MIL Case
MGF1	2.5	3.0	2,500	EB
MGF2	2.5	10.0	2,500	GB
MGF3	5.0	3.0	2,500	FB
MGF4	5.0	10.0	2,500	HB
MGF5	6.3	2.0	2,500	FB
MGF6	6.3	5.0	2,500	GB
MGF7	6.3	10.0	2,500	JB
MGF8	6.3	20.0	2,500	KB
MGF9	2.5	10.0	10,000	JB
MGF10	5.0	10.0	10,000	KB

PULSE TRANSFORMERS

Cat. No.	Blank'g Osc.	Int. Coup'g	Low. Pwr. Out.	Pulse Voltage Kilovolts	Pulse Duration Microseconds	Duty Ratio	No. of Wdgs.	Test Volt. KVRMS	Char. Imp. Ohms
MPT1	V	V		0.25/0.25/0.25	0.2-1.0	.004	3	0.7	250
MPT2	V	V		0.25/0.25	0.2-1.0	.004	2	0.7	250
MPT3	V	V		0.5/0.5/0.5	0.2-1.5	.002	3	1.0	250
MPT4	V	V		0.5/0.5	0.2-1.5	.002	2	1.0	250
MPT5	V	V		0.5/0.5/0.5	0.5-2.0	.002	3	1.0	500
MPT6	V	V		0.5/0.5	0.5-2.0	.002	2	1.0	500
MPT7	V	V	V	0.7/0.7/0.7	0.5-1.5	.002	3	1.5	200
MPT8	V	V	V	0.7/0.7	0.5-1.5	.002	2	1.5	200
MPT9	V	V	V	1.0/1.0/1.0	0.7-3.5	.002	3	2.0	200
MPT10	V	V	V	1.0/1.0	0.7-3.5	.002	2	2.0	20(
MPT11	V	V	V	1.0/1.0/1.0	1.0-5.0	.002	3	2.0	50(
MPT12	V	V	V	0.15/0.15/0.3/0.3	0.2-1.0	.004	4	0.7	700

AUDIO TRANSFORMERS
Freqv. resp. 300 to 10000 cps ± 2 DB. All Case Sizes AJ

Catalog No.	Application	Impedance Prim. Ohms	Impedance Ct.	Impedance Sec. Ohms	Impedance Ct.	DC Current Prim. P. Side Ma	DC Current Sec. Side Ma	Max. Level DBM
MGA1	Single or P.P. Plates — to Single or P.P. Grids	10K	V	900K Split	V	10	10	15
MGA2	Line to Voice Coil	600 Split		4, 8, 16		0	0	33
MGA3	Line to Single or P.P. Grids	600 Split		135K	V	0	0	15
MGA4	Line to Line	600 Split		600 Split		0	0	15
MGA5	Single Plate to Line	7.6K 4.8T		600 Split		40	40	33
MGA6	Single Plate to Voice Coil	7.0K 4.8T		4, 8, 16		40	40	33
MGA7	Single or P.P. Plates to Line	15K	V	600 Split		10	10	33
MGA8	P.P. Plates to Line	24K	V	600 Split		10	1	28
MGA9	P.P. Plates to Line	60K	V	600 Split		10	1	27

Send for further information on these units, or special designs. Also ask for complete laboratory test instrument catalog.

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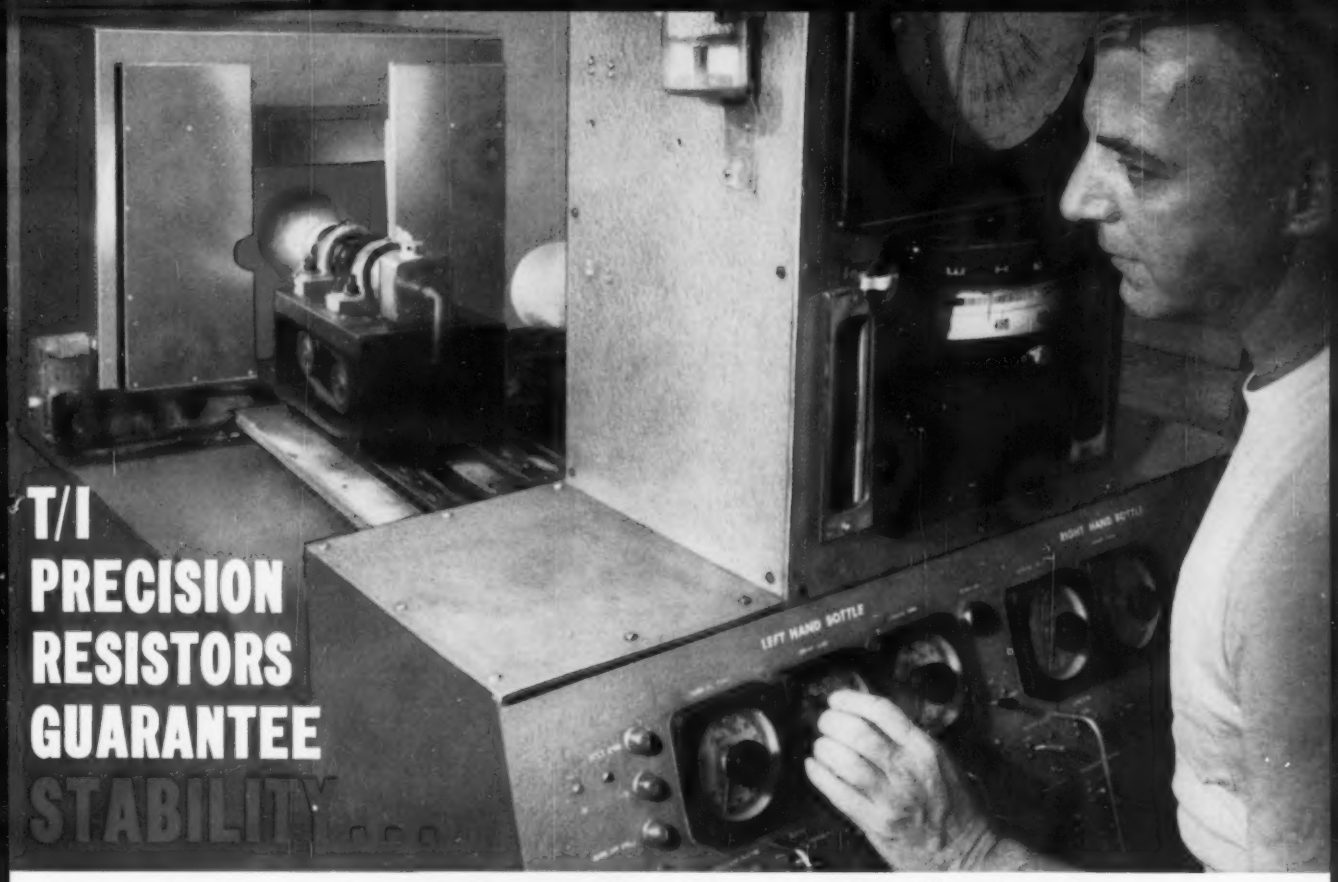
CIRCLE 148 READERS SERVICE CARD



T/I PRECISION RESISTORS GUARANTEE STABILITY

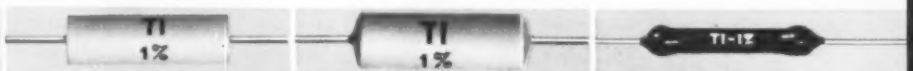
through exclusive ***automatically controlled processes***

Consistent TI resistor stability and performance for ***every run***, such as the carbon depositing operation shown above, are assured by exclusive ***TI automatically controlled processes.***

For your resistor applications that demand stability, TI precision carbon film resistors provide three full lines — hermetically sealed, molded, and mil-line.

Low negative temperature coefficient of resistance (0.03—0.05%/°C) provides reliable performance under full load with linear derating from 70° to 150°C.

For your next resistor application, select from one of the following encapsulations:



TEST	HERMETICALLY SEALED	MOLDED	MIL-LINE
Temperature Cycling per Mil-R-10509B (4.6.3)	+0.05 to −0.15%	+0.05 to −0.15%	0 to −0.15%
Low Temperature Exposure per Mil-R-10509B (4.6.4)	Less than ±0.10%	Less than ±0.10%	Less than ±0.10%
Short Time Overload per Mil-R-10509B (4.6.5)	0 to ±0.15%	Less than ±0.10%	Less than ±0.10%
Effect of Soldering per Mil-R-10509B (4.6.8)	Less than ±0.05%	Less than ±0.05%	Less than ±0.10%
Shelf Life, change per year	Less than ±0.10%	Less than ±0.10%	Less than ±0.10%
Insulation Resistance per Mil-R-10509B (4.6.7)	Greater than 1,000,000 Megohms	Greater than 100,000 Megohms	Greater than 100,000 Megohms
Voltage Coefficient	Less than 0.002%/Volt	Less than 0.002%/Volt	Less than 0.002%/Volt

AVERAGE PERFORMANCE OF TI RESISTORS*

HERMETICALLY SEALED: for highest reliability . . . solder sealed in a vitrified ceramic case for utmost protection . . . ⅛ to 2-watt ratings.

MOLDED: encased in a tough, molded jacket for protection against mechanical damage and moisture . . . ⅛ to 2-watt ratings.

MIL-LINE: new design provides full load performance at 70°C, derates linearly to 0 at 150°C . . . light weight . . . small size . . . exclusive TI multi-coat synthetic protection . . . ⅛ to 2-watt ratings.

* Unless otherwise noted, data is % change in total resistance

ALL LINES EXCEED APPLICABLE MILITARY SPECIFICATIONS.

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RCA's "straight" electron-gun is designed to minimize deflection distortion—and eliminates the need for an ion-trap magnet. Inches shorter in length than 90°-deflection types having the same size faceplate, RCA 110°-deflection picture tubes with super-aluminizing produce bright, high-contrast pictures.

RCA 110° picture tubes are available in quantity to meet your production schedule. RCA can also supply you with the horizontal and vertical deflection tubes for 110°-deflection systems. For further information, call your RCA Field Representative.

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